

Models of memory

Adaptive Control of Thought

- “ACT” theory (John R. Anderson, '76, '83, '91)
- Extension of hierarchical model
 - But better!
- Attempts to explain
 - Learning
 - Memory
 - Language
 - Reasoning
 - Problem solving

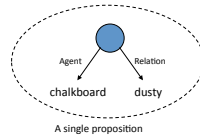
ACT model

Proposition: smallest unit of meaning that can be falsified.

~~Not proposition~~ ~~Dusty~~

Proposition T The chalkboard is dusty.

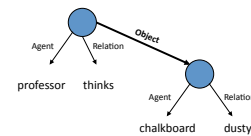
Proposition F The professor is dusty.



ACT model

Proposition: Kind of like a sentence, but **one** sentence can contain **multiple** propositions

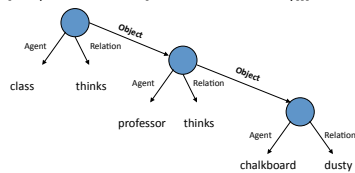
[The professor thinks [the chalkboard is dusty]]



ACT model

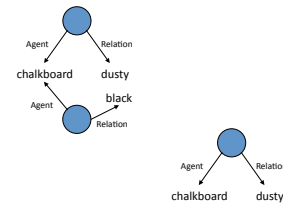
Proposition: Kind of like a sentence, but **one** sentence can contain **multiple** propositions

[The class knows [The professor thinks [the chalkboard is dusty]]]



ACT model

Proposition: Kind of like a sentence, but **one** sentence can contain **multiple** propositions



ACT model



ACT model

Another issue: what about *particular* instances?

Not really what we mean.

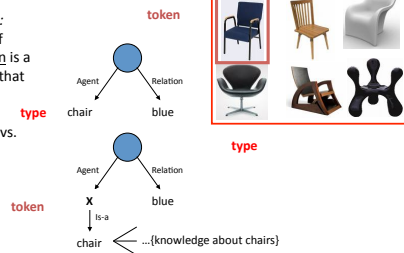


ACT model

Another issue: what about *particular* instances?

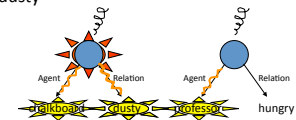
Type-token distinction:
A **type** is just a class of objects/things; a **token** is a particular instance of that class.

Compare to semantic vs. episodic.



ACT model

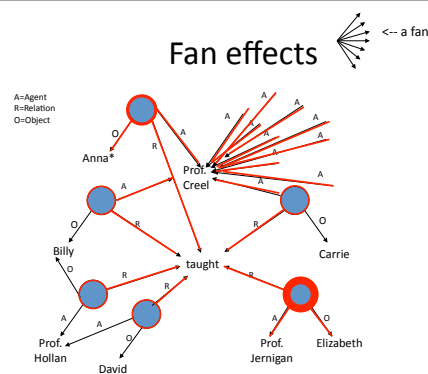
- Spreading activation
 - Nodes activate, intersect if connected to same proposition
 - Have you seen this sentence?
 - The chalkboard is dusty
 - The professor is dusty



ACT model

- The evidence
 - Getting the “gist”
 - Jim told Ed about the fun exam
 - = Jim and Ed talked about the fun test
 - ≠ Jim told Ed about the bad exam
 - Nurse primes doctor
 - *Fan effects*

Fan effects

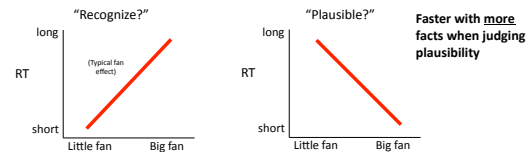


* All student names have been changed to protect anonymity.

So the more facts you know, the harder it is to access one.
 But aren't we faster to recall more about what we know a lot about?
 If based on *plausibility*, more facts leads to **faster** response.

Fan effects & plausibility

- Reder & Ross (1983)
 - Learn facts with different fan sizes
 - Then test either
 - Strict recognition or
 - Plausibility



One more model...

Parallel Distributed Processing (PDP)

- E.g. McClelland & Rumelhart (1986)
- Very different approach than ACT
 - Representations
 - Localist (ACT) vs. distributed (PDP)
 - Combines episodic and semantic
 - Episodes "add up to" semantics
 - Brain-inspired
 - Nodes and links (\approx neurons & their connections)

Parallel Distributed Processing (PDP)

- Localist (ACT) vs. distributed (PDP) representations: why?
 - "grandmother cell"
 - Store many patterns in one network

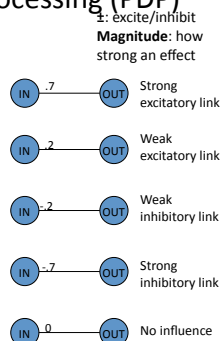
Parallel Distributed Processing (PDP)

- Combining episodic and semantic
 - Episodes "add up to" semantics
 - Multiple encodings of same/similar events strengthen memory, form a generalization (semantic memory)
 - Embodies idea that all remembering occurs in the context of every other memory
 - Remembering is being given partial information and "filling in" the rest (pattern completion)

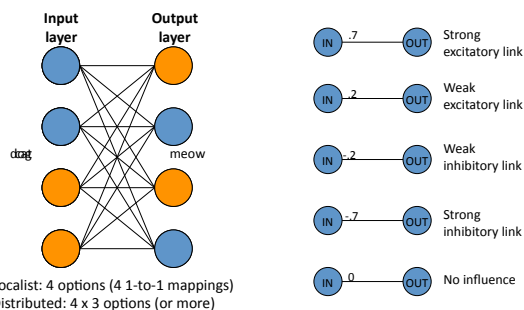
Parallel Distributed Processing (PDP)

- Brain-inspired

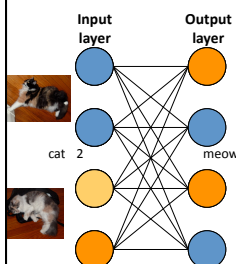
- (Not quite like a real brain, but...)
- Nodes = neurons
- Connections = synapses
- A little like IA model, but that was localist too
- Excitatory (+) & inhibitory (-) connections
- Goal: map inputs to outputs
- Both inputs and outputs are *patterns of node activations*--i.e., distributed



PDP model of memory

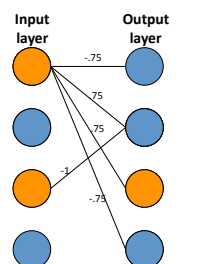


PDP model of memory



- Nodes: 0-1
- How do we map inputs to outputs?
 - What changes?
- The **connection weights**
 - Like synapses
 - No need to add nodes (new neuron if grandpa remarries?)

PDP model of memory



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Schemas and Scripts

Organization of knowledge

- Test example
 - John picked up a test from the TA.
 - He worked for an hour and twenty minutes.
 - He left feeling extremely worried.
- What we know
 - John possessed a copy of the test.
- What we “know”
 - John took an exam.
 - He worked **on the exam**.
 - He was worried **about his exam performance**.

Organization of knowledge

- Schema (pl. "schemata" or "schemas")
 - Knowledge about complex situations
 - Helps you understand the current situation
 - You're not trying to remember a list of events to report later to a scientist (as in a serial recall experiment)—
 - You want to get what you need out of the situation
 - **Top-down** knowledge (fill-in)

The last time you dined out...

- Can you remember...
 - Less schema-relevant {
 - What was waitperson's name?
 - How they took your order, word for word?
 - Schema-relevant {
 - Was the service good?
 - What you ate?
 - Whether the food contained a foreign object?

Schemas

- Test example
 - John picked up a test from the TA.
 - He worked for an hour and twenty minutes.
 - He left feeling extremely worried.
- Assumptions are filled in from schemas
 - **Meaning = input + activated knowledge**
 - (Hmm, what if you activate the wrong knowledge?)
 - You're **actively constructing** meaning
 - To understand is to come up with an **integrated representation**.

Schemas

- Activating different knowledge results in a different understanding
 - Anderson et al. (1977): prisoner story
 - Could also possibly be construed as wrestling
 - Test on people who are/aren't activating wrestling knowledge a lot
 - Are (PE majors): 64% "wrestling" responses
 - Not (music majors): 28% "wrestling" responses

Schemas

- What they are
 - Your knowledge about how the world works (based on your experiences)
 - General--about **type** of situation (not token/episode)
 - Structured relationships, not just set of facts
 - Used to understand the world

Example: CLOTHING schema

Slots

- Torso covering:
- Leg covering:
- Head:
- Feet:

Values

- T-shirt
- **Nothing**
- **Jeans**
- Sandals, sneakers, pumps

- Slots are *specific* and contain *defaults*

Schemas

- Can have embedded schemas
 - Going-to-dinner schema
 - Ice-cream-truck schema
- Benefits of schemas
 - Infer things that aren't directly observed
 - *Predict* upcoming stuff
 - Jan was at a party talking to a very attractive individual.
 - She then noticed a ring on that person's left hand.
 - What is Jan going to do?

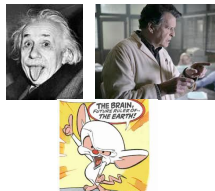
} Purchase-stuff schema

Schemas

- Influences on memory
 - *Place* schemas
 - Dorm room; grad student office
 - Are there books in your TA's office?
 - Brewer & Treyns (1981): 30% say "yes" when no books were actually present
 - Markman & Gentner (1997)
 - Activated schemas by juxtaposing similar pictures...

Schemas

- Stereotypes
 - Scientist
 - Test tubes & symbols
 - Caucasian (?)
 - Male
 - Boutla et al.
 - 2008: Of those using pronoun in discussing this on a problem, **all** used he/him
 - Boutla is a woman!



Scripts

- Specific type of schema
- Used for stereotyped event sequences
 - Going to dinner, getting ice cream, taking exam
- Contains:
 - Set of **ordered** actions
 - **Causal links** between events
 - E.g. tip depends on good service

Scripts

- Evidence for scripts (Bower et al. 1979)
 - **Study 1**
 - Presented 6-action passages
 - Later, gave titles & asked to recall exactly
 - Correctly recalled: 3 out of 6
 - Filled-in: 1 **extra fact** that didn't take place
 - *Recall was based on familiar series of events*

Scripts

- Evidence for scripts (Bower et al. 1979)
 - **Study 2**
 - Present 10 lists of actions
 - Some lists in order, others out of order
 - Asked people to recall actions
 - In order lists: 50% correct order at recall
 - Out of order lists: only 18% correct order
 - *Recall was structured around familiar order*

Scripts

- Problems
 - What about things that don't have a particularly stereotyped order of occurrence?
 - Going to the bathroom at a restaurant
 - (Where does this fit in?)

Schemas

- General problems
 - Slots:
 - Dining out: *diner*, *food_type*, transportation
 - Can't account for **dependence** between slots
 - Going-to-dinner schema
 - If *diner* is person A, *Thai food*
 - If *diner* is person B, *nothing with meat & walkable*
 - Better captured by PDP-type models

When memory goes bad

Is memory accurate?



Reconstructive memory

- In recalling an event, sometimes other stuff is recalled with it that's not part of it
 - Esp. for complex events, may put multiple pieces together--*reconstruct*
 - Errors when you probe with cues from part of a recollection to retrieve the rest

Reconstructive memory

- Example:
 - Actual event:
 - dinner (Cuban) & movie (*Wordplay*) w/Julia
 - Probe: movies seen with German friends
 - » *Wordplay*
 - » *An Inconvenient Truth*
 - Pull up *wrong* movie
 - » Remember: *Cuban & Inconvenient Truth* w/Julia

Reconstructive memory

- Error-prone memories (episodes)
 - *Poorly encoded ones*
 - Not processing lecture much
 - Ones *similar to other memories* (= encoding cues)
 - Spring quarter cog sci lectures
 - German postdoc friends in Philly
 - Not *recent*
- General picture: if you can retrieve only bits and pieces, you *fill in* to get a whole memory

Reconstructive memory

- Effects of retrieval cues
 - Anderson & Pichert (1978)
 - Participants read burglar/home buyer story
 - Asked to recall details from one perspective
 - 64% perspective-relevant facts recalled
 - 46% other-perspective facts recalled
 - (I.e., perspective matters)
 - *Then* asked to recall from the other perspective
 - Another 10% of facts suddenly came to mind!
 - Retrieval alone can “jog” memory
 - Tversky & Marsh (2000)
 - Recalling from a perspective can alter memory itself

Reconstructive memory

- Stereotypes (e.g. scientists, grad students)
 - Guide retrieval of events
 - Grad student is likely to have books in office
 - Probably encoding effects too
 - **Expectation** that grad students have books in office

Reconstructive memory

Big point: remembering isn't just about **pulling an experience out** of a little pigeonhole in your mind. You **filter it** through the rest of your world knowledge.

(Which usually works, but can sometimes get you in trouble.)

Memory issues in real life

- Eyewitness testimony
 - Misinformation effect
- Flashbulb memories
- False memory

Eyewitness testimony

- Assumptions
 - It's accurate
 - Certainty and accuracy are correlated
- Data
 - 75000 suspects ID'ed per year
 - Sometimes right, but not always
- One problem: *Misleading questions*

Eyewitness testimony

- The **misinformation effect** (Loftus, Burns, & Miller, 1978)
 - Slide show of car accident
 - Half saw YIELD sign, half saw STOP sign
 - Questionnaire
 - Misleading question (“stopped at stop/yield sign?”)
 - No misinformation (“stopped at intersection?”)
 - Pick YIELD slide or STOP slide
 - No misinformation: 85% correct
 - Misleading-Q group: 38% correct :-{
 - **Memory has been overwritten/revised**

Eyewitness testimony

- The **misinformation effect** (Loftus, Burns, & Miller, 1978)
 - How does this happen?
 - Overwriting (“destructive updating”)
 - Source confusion
 - Misinformation acceptance

Misinformation effect

- Source confusion explanation
 - Like trace interference
 - Original memory is there, but not clear where it came from
 - Lindsay & Johnson (1989):
 - If given a misleading suggestion, it is also recalled and it may be incorrectly remembered as the thing you saw

Misinformation effect

- Misinformation acceptance
 - You’re totally aware that you didn’t know
 - But you assume that the misleading information was correct
 - Why would a lawyer say something inaccurate?

Misinformation effect

- Loftus: overwriting
- McCloskey & Zaragoza (1985): misinformation acceptance

Misinformation effect

McCloskey & Zaragoza (1985)

- Set-up
 - See theft from under **hammer**
 - Narrative w/ or w/o misleading **screwdriver**
- Test
 - Loftus version: **hammer** vs. **screwdriver**
 - Modified version: **hammer** vs. **wrench**
- Result: screwdriver misleads, wrench not
- M&Z: misinformation acceptance
 - Does not support overwriting

Screwdriver must not overwrite because hammer “still there”

Misinformation effect

- But Lindsay (1990): source confusions
 - Subjects in Loftus, M&Z weren't *aware*
- To test non-awareness of where info came from:
 - Event happens
 - Misleading narrative happens
 - 48 hours go by...
 - Just before test: "narrative was made up"
 - If they know the source, should dismiss misleading info
 - But they didn't—often recalled narrative information!!
- **Source confusions do occur**
 - Retrieval cues? (Screwdriver > wrench)

Misinformation effect

- Effect is widely accepted
- Underlying explanation, less so
 - Some still hold to overwriting
 - More likely: source confusion
 - Real and fake info compete for recognition
 - Plausibility important too
 - "The car stopped at the stop sign, then a flying saucer hit the pedestrian. The car then fled the scene."

Memory issues in real life

- Eyewitness testimony
 - Misinformation effect
- **Flashbulb memories**
- False memory

Flashbulb memories

- Memories that "stand out" from others
 - College admission
 - First date
 - Historical events (easier to investigate)
 - JFK
 - Challenger
 - 9/11
- Really as "indelible" as they seem?

Flashbulb memories

- Indelibility: Brown & Kulik (1977)
 - Asked N=80 about JFK
 - What were you doing when you found out?
 - 79/80 remembered
 - 13-year delay (1963-1977)
 - Argued for distinct biological mechanism for storing surprising memories
 - Would have been crucial to survival
 - Little forgetting
 - Highly detailed, including circumstances surrounding

Flashbulb memories

- Neisser & Harsch (1992): not so fast.
 - Morning after 1986 Challenger explosion
 - Questionnaire to undergrads at Emory
 - What happened?
 - What were you doing?
 - Who told you? (and so on)
 - After 2.5 years, recontacted to be in study
 - Only 25% recalled taking questionnaire

When I first heard about the explosion I was sitting on my freshman dorm room with my roommate and we were watching TV. It came on a news flash and we were both totally shocked. I was really upset and I went upstairs to talk to a friend of mine and then I called my parents.

Neisser & Harsch, 1992, p. 9 / Textbook p. 234

Actual: found out in class, felt sad, watched TV for details

Flashbulb memories

- Neisser & Harsch (1992): not so fast.
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 - Questionnaire to undergrads at Emory
 - What happened?
 - What were you doing?
 - Who told you? (and so on)
 - After 2.5 years, recontacted to be in study
 - Only 25% recalled taking questionnaire
 - **Only 3/44 had perfect recall (assuming original q'aire true)**
 - **Little relation between confidence & accuracy**

Flashbulb memories

- Objections to N&H
 - Conway et al (1994)
 - Challenger explosion not consequential for people
 - Tested memory for Margaret Thatcher's 1990 resignation
 - UK, US, Denmark
 - Tested at 2 weeks & 11 months
 - » UK: 86% highly accurate
 - » US, Denmark: 29%
 - Good challenge
 - But maybe less well encoded to begin with

Flashbulb memories

- Maybe no special mechanism
 - Important, so likely to get rehearsed a lot
 - Very unusual--less interference
 - Strong emotional tone may affect memorability

Memory issues in real life

- Eyewitness testimony
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Recovered memories

- Terrible event forgotten for many years
- Sometimes necessitates criminal prosecution
 - Statute of limitations exception--criminal doesn't benefit from causing witness trauma
- Sometimes the accused protests

Recovered memories

- Agreed by all parties
 - Child abuse (or other criminal acts) are frequent, and *should* be punished
 - But also, innocent people shouldn't be punished
 - Sometimes no way to verify/falsify

Recovered memories

- Why aren't these **extra** memorable?
 - Repression.
- Is repression real?
 - Maybe.
- Proponents: once retrieved, very accurate and vivid
 - Again, hard to verify
 - Remember that confidence \neq reality

Recovered memories

- Opponents
 - No evidence that memories real
 - Therapists (trying to be helpful) may ask misleading questions or encourage erroneous reconstruction of events
 - We know recall can be inaccurate
 - Response: Sure, but lab experiences can't achieve *ecological validity*
 - Emotional trauma very strong
 - Extended abuse \neq stop sign!

A bit more on recovered memories

- Suggestibility
 - Porter & colleagues:
 - Lost in mall (15% implanted)
 - Enema (0% implanted)
 - Serious childhood animal attack: about 30%
 - Not a minor incident
 - A large proportion of people are suggestible

Recovered memories

- False memories induced
 - Getting lost in a mall (but not enema)
 - Details of childhood crib
- Alien abduction victims: Clancy et al. 02
 - More suggestible
 - More prone to false memory effects
 - Candy, sugar, honey... report "sweet"

Final issue: false *confession*

- Causes:
 - Emotional stress
 - Social pressure
 - Suggestion
- Example: Central Park Jogger case
- Distrust memory enough
 - If you think it's possible to repress horrific memory, you might believe you've done it
- "Interrogative suggestibility" (Gudjonsson)
 - Tested people who made confession, later retracted
 - They were more prone to suggestive questions

Final issue: false *confession*

- Experimental false confession (Kassin)
 - “Type spoken letters--don’t hit ALT!”
 - Fast or slow
 - Experimenter: false accusation
 - Subject: no, I didn’t
 - Confederate: “I saw you do it!” ($1/2$ subj’s)
 - Overall, **70% signed a confession**
 - If typing fast **and** confederate, all
 - And 35% had a detailed recollection about it!!
- But again, problem of scale
 - ALT key isn’t exactly a dagger

Low certainty of own memory

Misleading question

Memory issues in real life

- Eyewitness testimony
 - Misinformation effect
- Flashbulb memories
- Recovered memory
- False confession

Memory issues in real life

- Common threads:
 - Great confidence
 - Possible inaccuracy

Hypnosis and memory

- Used in therapy, on eyewitnesses
- Scientific findings
 - Does not improve list recall
 - Driest lab test possible
 - Hypnotized subjects recall more vs. controls
 - Stuff on the list
 - Stuff **NOT** on the list
 - Overall, no improvement (+signal but +noise too)
 - Sometimes **not as well as** control subjects who are encouraged strongly to try their best

Hypnosis and memory

- Used in therapy, on eyewitnesses
- Scientific findings
 - Does not improve list recall
 - **Does** increase confidence in memory
-

Hypnosis and memory

- Used in therapy, on eyewitnesses
- Scientific findings
 - Does not improve list recall
 - **Does** increase confidence in memory
- Some states exclude testimony

Alternatives to hypnosis

- Are there better ways?
 - *Cognitive interview* (Fisher & Geiselman)
 - No misinformation provided
 - “Report everything” (not just specific questions)
 - Ask witness to reinstate context
 - Ask witness to take different perspective
 - Results: better recall, with a little bit of erroneously-recalled info
 - Used to train English & Welsh police

“Special” memories?

- Eyewitness testimony
 - Misinformation effect
- Flashbulb memories
- Recovered memory
- False confession

Upshot: there’s no such thing as a free lunch.

These memories are prey to everything that “normal” memories are susceptible to, despite the subjective feeling of certainty that often surrounds them.

Extraordinary memory and metamemory

Really, really good memory

- What about those people who can memorize phone books?
 - Yes, they exist.
 - No, they’re not fundamentally different from anyone else.

Really, really good memory

- Individual differences
 - Aren’t we all working with the same equipment?
 - Factors
 - Motivation to learn
 - More interested in material
 - Just plain better memory
 - Evidence:
 - **Strategies**
 - **Prior knowledge**

Really, really good memory

- Strategies we’ve already discussed
 - Pay attention at encoding!
 - If you don’t think about someone’s name, you won’t remember it later
 - Rehearse in multiple ways
 - Relate to knowledge (looks like a Roxanne I went to grade school with)
 - Elaborate (imagine her at La Jolla Cove where there were *rocks* and *sand*)
 - Set up a good *retrieval plan*
 - Imagine (or practice) giving your report in auditorium
 - Retrieval cues will better match encoding cues

Really, really good memory

- Existing schemas/domain knowledge
 - Spilich et al. (1979): baseball
 - Memory for melodies
- In an unfamiliar domain
 - Things go “in one ear and out the other”
 - Expert performance seems ‘magical’ to you

Memory experts

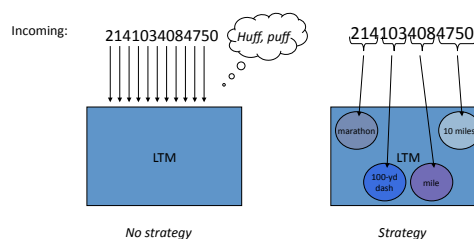
- 7 ± 2 is normal STM limit
- Chunking helps (even if not meaningful)
- Chase & Ericsson (1981)

Memory experts

- Chase & Ericsson (1981)
 - Trained people to chunk
 - Subject 1: runner, chunked into running times for different races; got up to **80 digits**
 - Crazily-talented person?
 - Subject 2: trained w/same strategy, got up to **40 digits** with \approx same rate of improvement

Memory experts

- Chase & Ericsson (1981): **HOW?**



Memory experts

- Chase & Ericsson (1981)
 - Great, but so what?
 - Wouldn't generalize to (e.g.) letter sequences or grocery lists
 - Your chunks have to match what you're memorizing

Memory experts

- Mnemonists
 - Use *mnemonics*
 - Examples:
 - Bizarre images
 - Homework for a class grows legs, leaps into your bag just before class
 - Method of loci (for ordered things)
 - Mentally navigate a familiar path
 - Put the to-be-remembered things at points along path
 - PPMDAS, EGBDF (order of operations, lines on staff)
 - Point: you aren't going to forget sentence order
 - Banks off of knowledge of grammar

Memory experts

- Luria (1968): "S"
 - 70 words in memory span task
 - And backwards
 - And the next/previous word, given any word
 - Synaesthete (A is blue, etc.)--rich encoding
 - Had to also use method of loci and others
 - Quit journalism to become professional mnemonist
 - Sometimes didn't pick up on simple consistencies

1 2 3 4
2 3 4 5
4 5 6 7
...

Metamemory

- Knowing what you know (and *how well* you know)
 - Do I know James Bond's phone number?
 - Is it reasonable to forget my keys?
 - Do I need to read over my notes again?
- Are we good at this?
 - E.g. false confidence in memory
 - Usually we *are* good

Metamemory skill

- Nelson et al. (1994): good metamemory
 - Participants learned new (Swahili) words
 - Experimental group estimated how well each word was learned
 - Experimenters used these estimates to increase/decrease study of poorly/well-learned words
 - Experimental group > control group

Metamemory skill

- Infer well-encodedness by property of memory
 - Level of detail
 - Speed of recollection
- Big area of interest