Wickens’ HIP Model
- Temporary store for sensory input
- Decays very rapidly (~1/4 sec)
- 2 types: iconic & echoic (visuospatial sketchpad & phonological loop)

- Need a trigger to store it
  - Prompt or expectation
  - Attention is critical:
    - Selecting things from the sensory register to commit to STM
Short-Term Memory

- Limited-capacity store for working info
  - Capacity: $7\pm2$ (more or less)
  - Fades fast: “half-life” roughly 7 sec for 3 chunks and 70 sec for 1 chunk

- Elaborative rehearsal
  - Commits information to LTM
  - Associate new info with existing knowledge

- Maintenance rehearsal
  - Constant refresh
  - Keep items in STM without commitment
How many?
How many?
Long-term memory

Types of LTM

Explicit memory
- Facts

Procedural memory
- How to do things

Episodic memory
- Things that happened
Factors Affecting Recall from LTM

- **Strength**
  - Determined by frequency and recency of use

- **Associations**
  - Number of different associations increases likelihood of recall
  - Rote memory is fragile

- **Forgetting**
  - Depends on strength of memory and degree of association
Your username must contain **at least one letter** and **at least one number**.

Your password should be a combination of **at least 7 characters**, **including 1 letter, and 1 number (no spaces)**. Passwords are case sensitive (for example "2myhealth" and "2Myhealth" are not the same).
Consider…
Learning: The process of storing things in long term memory
Classical and operant conditioning

Classical: Stimulus -> response

Operant: Behavior -> outcome
Operant Conditioning and HCI

- Learning by trial and error is common
  - Clear feedback supports learning
  - Inadequate or inconsistent feedback subverts learning

- Typical forms of Operant Conditioning
  - Positive reinforcement: Behavior is followed by desirable stimulus
  - Negative reinforcement: Behavior results in removal of unpleasant stimulus
  - Positive punishment: Behavior is followed by undesirable stimulus
  - Negative punishment: Behavior results in removal of desirable stimulus
Learning Experiments

- Paired Association
- Serial List
- Free Recall
- Recognition
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Response used as stimulus

Repeated response
4 5 7 8 9 3 9
Blanket
Armor
Carrot
Faucet
Shoelace
Penguin
Scissors
Cockroach
Blue
Tiger
Black
Lion
Red
Jaguar
Pink
Cheetah
Flarbaugh
Sequod
Tambisk
Chrintor
Galtum
Hurbing
Vistoup
Angulk
Paired associate learning

- **Task:**
  - Present subject with stimulus-response pairs
  - Ask subject to supply response when given stimulus
  - Example: BEH->GUF; BEH->?

- **Results:**
  - Unfamiliar words harder to learn
  - Hard when response words are reused for multiple stimulus
  - Hard when stimulus words are used as responses for others
Task:
- Subject is presented with a list of items
- When presented with an item, recall the next

Results:
- Harder when trying to remember long lists
- Harder to remember things in the middle
**Task:**
- Subject is presented with a set of items
- Subject is asked to recall as many as possible

**Results:**
- Tougher to recall words that are unfamiliar
- The more associations among the words the better
- Words are recalled in “random” order, regrouped according to association
Task:
- Old-New: Subject is presented with items and asked was item seen previously?
- Correct-Incorrect: Paired association, but easier
- Forced-Choice: Either of above, with multiple-choice

Results:
- A lot easier than recall tasks
- Harder when similar items are used in old-new task
Consider...

```
alias ansiprint assets bg cat cd chmod chmod compress cp diff fg finger ftp grep head help history jobs kill logout ls lynx man msg mkdir more mv passwd pico pine ps pwd rm rmdir spell telnet vi w wc
```

$
Learning Curves

Easy at first, harder to gain much later

Hard at first, greater payoff after initial investment

http://www.frontier.net/~grifftoe/images/learningcurve.gif
Learning Curves

Performance vs. Time/effort

- System A
- System B
Unused information slips away

Because it's exponential decay, most of the forgetting happens soon

Fairly Easy to re-remember with priming
Transfer and Interference

- Existing schemas influence how we interpret new information
  - Positive influence: Transfer
  - Negative influence: Interference

- Proactive interference
  - Something you learned before impacts what you are trying to learn now
  - Implication: use existing patterns

- Retroactive interference
  - Something you learned recently impacts previously held knowledge
Transfer? Interference?
Transfer? Interference?
Memory consists of multiple stages, each with different properties.

Designers must work within the constraints of human memory, and should augment it where possible.

Learning is of central importance to HCI—every system must be learned.

Designs can help or hinder learning. It’s important to know how.