Memory

Memory

- …Is everything. (H.M. example)
- Has many different functions
  - Have you seen this child?
  - What is James Bond's telephone number?
  - What car did he drive?
  - What kind of car does he typically drive?
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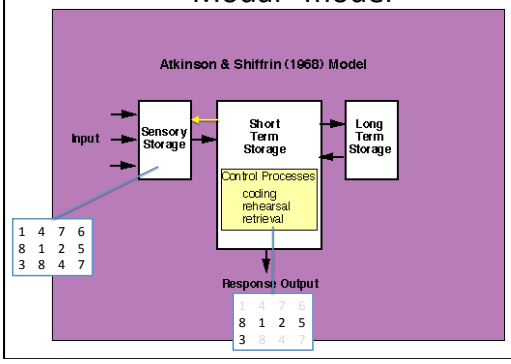
Short-term memory

- AKA primary memory
- Attend to info and make it available to
  - Process further
    - Phone number
    - Bad puns
  - Store long-term

"Modal" model



Short-term memory

- Processing: [Maintenance] rehearsal
- Losing it:
  - **Interference** from other tasks
    - Peterson & Peterson (1959)
      - See BKF
      - Then, count backward by 3's from 397 (try it)
        - » (Thus you can't rehearse B-K-F)
      - The longer you count, the more memory decreases

Short-term memory

- Processing: [Maintenance] rehearsal
- Losing it:
  - **Interference** from other tasks
  - **Forgetting**: newer items overwrite
    - *Limited capacity*: You can only cram so much into STM
    - Dialing an outside number from my university phone:
      6 + * + 1425367 + 8 + 803 444 4231

Short-term memory

- Coding: I.e., **what form do the representations take?**
  - Computer metaphor
  - Concerns STM and (you guessed it) LTM
    - *Very* big deal in LTM
  - How do you test this?
    - *Interference* of various sorts

Short-term memory

- Coding: I.e., **what form do the representations take?**
  - Conrad (1964)
    - View sequence of consonants: MSTLJX
    - Read random *digits* aloud (no rehearsal)
    - **Ding!** (Recall now)
    - Confusions: **acoustic** (M -> N, T->D)
      - * But with *articulatory suppression* during presentation, not acoustic (high error %)
      - Note: letters interfere with EACH OTHER

Short-term memory

More proof for acoustic storage:
Phonological similarity effect

cap dog leaf toy pin cage yarn gross fit

cap fat fan tap can sand cat ham lap

cap dog leaf toy pin cage yarn gross fit

cap fat fan tap can sand cat ham lap

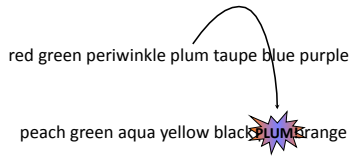
Short-term memory

- Coding: I.e., **what form do the representations take?**
  - Phonological similarity effect
    - Harder to remember things with more overlap
    - Why *digit span > letter span*
      - One, seven, five, three, six, two
      - Bee, gee, dee, eff, em, ess

Short-term memory

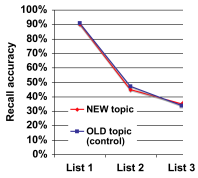
- Coding: I.e., **what form do the representations take?**
  - Wickens (1972): release from *proactive interference*

This is proactive interference:



Short-term memory

- Coding: I.e., **what form do the representations take?**
  - Wickens (1972): release from *proactive interference*
    - List 1: topic 1
    - List 2: topic 1
    - List 3: topic 1
    - List 4: **topic 2**
  - **Semantic** coding
    - (meaning-based)

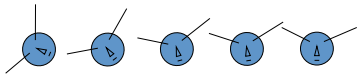


Short-term memory

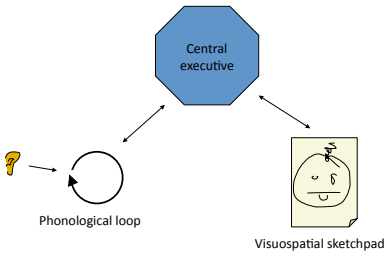
- Coding: I.e., **what form do the representations take?**
  - **Chunks**
  - George Miller (1956)
    - Limit on STM not *physical unit* but **chunk** of information
  - Chunks are based on prior knowledge, which varies from person to person

Working memory

- Baddeley & Hitch (1974):
  - STM isn't just a storage receptacle…
  - It's a workspace
- (If you like STM, you'll *love* WM!)
- Lets you **manipulate**, not just hold onto, information

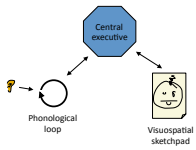


Working memory



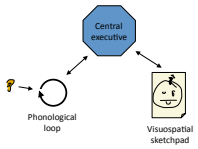
Working memory

- Phonological loop
  - Components:
    - Phonological store: about 2 seconds
    - Articulatory control process: refreshes store
  - A lot of the effects we've already talked about
  - Specialized for language learning?
  - The two-second limit
    - Welsh vs. English digit span (Ellis & Hennelly '80)
    - Really?

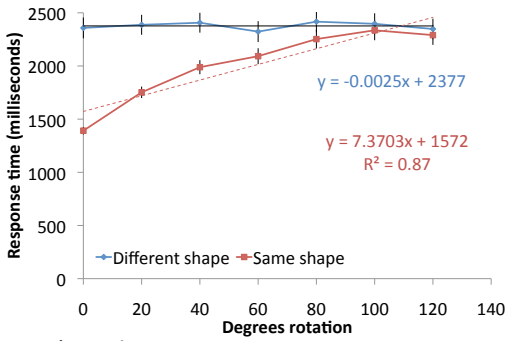


Working memory

- Visuospatial sketchpad
  - Maintain and operate on visual images
  - Farah & colleagues: maybe separate
    - Visual
    - Spatial*



Visuospatial sketchpad



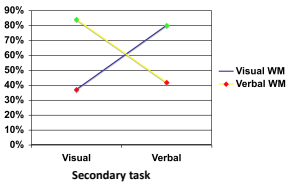
Mental rotation, **N**=200

Working memory

- Loop & sketchpad: really separate?
  - Logie et al. (1990): dual tasks

Primary task
- List of C's, then list with one changed (find it)
- Change of one square in B&W pattern

Secondary task
- Visualization task
- Sum digits task



Working memory

- Central executive
  - Allocate attention to different components
  - Utilize outputs of p.l. and v.s.
  - Baddeley & Hitch (1994): it *does* exist
    - Alzheimer's patients
    - Digit span and motion tracking
    - Normal performance in isolation
    - Much more impaired when doing both
      - Central executive can be selectively affected

Working memory

- Limits on phonological working memory
  - Time limit?
    - Word length effect
    - Disputed!
  - Complexity limit?
  - What if you can't hear?

Language, modality, & WM

- Boutla et al. (2004)
  - Q: Do ASL signers have a reduced STM* capacity?
  - Typical test: digit span
  - Problems:
    - Digits in ASL very phonologically similar
    - Length differences between spoken & signed
  - Solutions:
    - Control for length by having people read lists
    - Use *letters* that are less similar

Language, modality, & WM

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Language, modality, & WM

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  - Q: Do ASL signers have a reduced STM* capacity?
  - Hearing: digit span vs. ASL: letter span
  - Hearing > ASL (6.4 vs. 4.9)
  - Bilingual: English > ASL (7.1 vs. 5.2)

Language, modality, & WM

- Boutla et al. (2004)
  - Q: Do ASL signers have a reduced STM* capacity?
  - STM: Hearing > ASL (6.4 vs. 4.9)
  - **Working memory** task (no serial order component)
    - Hole, fish --> "She fell in a hole; he caught a fish…"

Language, modality, & WM

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  - STM: Hearing > ASL (6.4 vs. 4.9)
  - **Working memory** task (no serial order component)
    - Hole, fish --> "She fell in a hole; he caught a fish…"
    - Hearing = ASL (≈ 3)

Language, modality, & WM

- Boutla et al. (2004)
  - **Q: Do ASL signers really have reduced STM?**
  - **A_1: Yes,** STM is smaller even controlling for
    - Word length
    - Phonological similarity
  - **A_2: However,** WM no different when serial order component removed
  - Why--better temporal-order encoding in auditory modality?
  - Same as visuospatial sketchpad?

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Memory: the Big Picture

- Organization
  - Stuff you're processing at moment (STM/WM)
    - May be remembered only briefly (seconds)
    - Auditory/visuospatial distinction
  - Stuff you know (Long Term Memory)
    - Remembered for long period of time (years)
    - Episodic/Semantic distinction
    - Declarative/Procedural distinction
    - Implicit/Explicit distinction

(We'll get to this later.)

Long-term memory

- How does it get in there?
- How do you get it back out?

Long-term memory

- How does it get in there?
  - Some sort of **encoding**
  - Factors affecting how good encoding is
    - Rehearsal time
    - Depth of processing
    - Memory for meaning
    - Organization
    - Elaboration

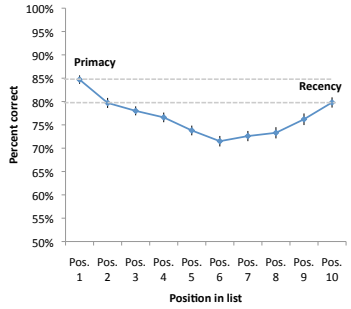
Long-term memory

- Studying LTM: **free recall**
  - Present a list of words/items
  - Ask participants to recall them
  - (You've done this)

Serial position

- Serial position curve
  - Strategies?
  - STM component
  - LTM component

N=203



Long-term memory

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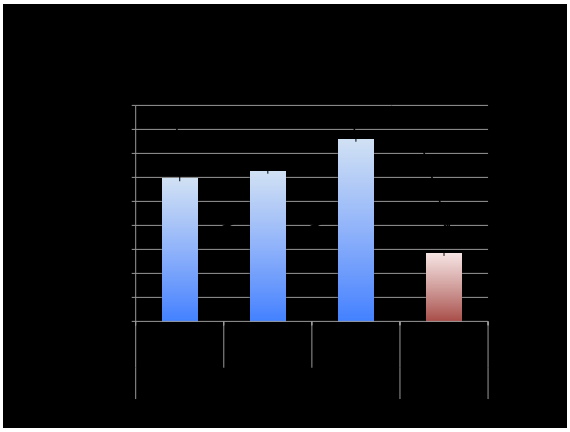
  - Some sort of **encoding**
  - Factors affecting how good encoding is
    - (Rehearsal time)
    - Depth of processing
    - Memory for meaning
    - Organization
    - Elaboration

Long-term memory

- Levels of processing (Craik & Lockhart, 1972)
  - AKA depth of processing
  - Types of processing
    - Shallow: Font, capitalization 17%
    - Medium: Rhymes with 37%
    - Deep: Pleasantness, fits in sentence 65%
  - Objection: what's 'deep' or 'shallow'?



Long-term memory

- Memory for meaning
  - Read: Jim told Ed about the fun exam.
  - Later, read:
    - Jim and Ed talked about the fun test. **OK**
    - Jim told Ed about the bad exam. **X**
  - Bransford, Barclay, & Franks (1972):
    - People can't tell literal sentence from one that preserves meaning.
    - They easily notice meaning changes.

Long-term memory

- Organization (Bower et al., 1969)
  - Present list in random order
    - Oscar Raphael Alvin BigBird Theodore Leonardo Simon Donatello
  - Or grouped by category
    - Leonardo Donatello Raphael Alvin Simon Theodore Oscar BigBird
  - Recall **vastly** better for grouped
  - (Note that *number of presentations* also helped)

Long-term memory

- Elaboration
  - Relate new information to existing knowledge
  - Stein & Bransford (1979)
    - The vet read the directions. *No elaboration*
    - The vet read the directions printed in English. *Irrelevant elaboration*
    - The vet read the directions on the flea medicine applicator. *Relevant elaboration*
  - Better recall (fill-in-the-blank) with relevant elaboration
  - Esp. helpful for older adults
  - May bias us to warp new info to fit known info :-(

Long-term memory

- Retrieval
  - Retrieval *plan* (easier to recall)
  - Retrieval context = encoding context
  - Recognition (Have you seen me?)
  - Recall (What word goes here?)

Long-term memory

- Recognition > recall--usually.
  - What's the name of President Obama's older daughter?
  - Is it Maria or Malia?
- Why?
  - Degree of encoding/retrieval matching.
  - Really? Are there cases where recall > recognition?

Long-term memory

- Encoding specificity (Tulving & co.)
  - Hold on, this is kinda complicated…

Phase 1: learn all-caps words

Head	LIGHT
Grasp	BABY
Sandwich	FINGER
Laugh	STOMACH

Phase 2: generate 6 words

Word	You:
Dark	"black,light,outdoors,scary…"
Infant	"child,baby,kid,blanket…"
Intestine	"stomach,hungry,…"

Phase 3: circle words that were caps-words from Phase 1
(*this is a **recognition** task*)

Original retrieval cue
"Grasp _____"
is ***missing***

Word	You:
Dark	"black,light,outdoors,scary…"
Infant	"child,baby,kid,blanket…"
Intestine	"stomach,hungry,…"

22%

Phase 4: Now *recall* caps-words given original cue words
(*this is a **recall** task*)

Original retrieval cue
"Grasp _____"
is **now present**

Grasp BABY
Head LIGHT
Laugh _____

59%

Recall > recognition *When retrieval cues are swapped*

Long-term memory

- Encoding specificity vs. processing depth
  - Fisher & Craik:
    - If no cues, use semantics
    - But give recall cues
    - Shallowish cue: "rhymes with -eel"
      - Rhyme encoding: 40% recalled
      - Sentence encoding: 29% recalled
      - Retrieval cue flips effect over!
    - (Note: sometimes shallow cues are better if no semantic encoding is obvious--e.g. names)

Long-term memory

- Context effects
  - Physical environment
    - Godden & Baddeley (1975): Scuba divers
    - Test room

Long-term memory

- Context effects
  - Physical environment
    - Godden & Baddeley (1975): Scuba divers
    - Test room
  - Real-life: seeing someone in unfamiliar location
  - Internal state
    - Drugs (*state-dependent recall*)
    - Mood

Long-term memory

- Odor as a context effect
  - Strongly associated with emotion-laden events
  - Just like other context effects?
  - Maybe not: Herz (1998) list learning
    - No odor/no anxiety
    - Odor/no anxiety

    No difference
    - No odor/anxiety
    - Odor/anxiety

    Better recall w/odor

Long-term memory

- Spacing effects: distribute, don't mass!

  fall leaf leaf roof cap roof fall cap

- Best remembered: fall
- Worst remembered: leaf
- Why?

Long-term memory

- Spacing effects

  fall leaf leaf roof cap roof fall cap

- Best: fall; worst: leaf

Long-term memory

- Spacing effects

- Best: fall; worst: leaf
- Explanation #1: encoding differences
  - Meaning
  - Time itself (massed better @ v. short lags)

Long-term memory

- Spacing effects

- Best: fall; worst: leaf
- Explanation #2: reminders

Long-term memory

- Spacing effects
- Works even over very long term (Bahrick[4])
  - Study L2 vocab at 2-, 4-, 8-week intervals
  - Equal number of practices on each word over 4 years
  - For next **five years**, better at longer interval words!

Long-term memory

- Forgetting: Does LTM ever go away?
  - E.g. blanking on name of h.s. classmate
  - Is the memory
    - Gone
    - Or just insufficient retrieval cues?

Long-term memory

- Forgetting = Insufficient retrieval cues?
  - Evidence it's still "in there"
  - Weird evidence:
    - Brain surgeries
    - But compare transplant recipients*
    - Certainty ≠ truth (as we will see in a couple of weeks…)

Long-term memory

- Forgetting = Insufficient retrieval cues?
  - Intentional forgetting
    - Easy for computers, hard for us
    - Face, trumpet, card, mush…
    - *FORGET!*
    - …leek, mustard, grant, drum
    - Recall: as if pre-forget hadn't happened (serial position)
    - Recognition: face, card (e.g.) easily recognized

Long-term memory

- Forgetting = Insufficient retrieval cues?
  - Savings in relearning (Nelson et al 1979)
  - Day X: learn wd/# pairs (e.g. 42-life, 30-great)
  - Day X+30: test for recognition
  - **Unrecognized** pairs are retaught
    - Original pairings (42-life, 30-great) **57%**
    - Switched (42-great, 30-life) **22%**

Long-term memory

- Forgetting: underlying causes
  - Decay
  - Interference
  - Overwriting

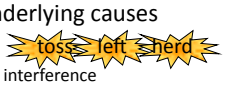
Long-term memory

- Forgetting: underlying causes
  - Decay
    - TRACE
    - "Law of disuse"
    - Is memory decay hypothesis true?
      - If decay happens over time, **shouldn't** matter what the intervening material is.
      - Jenkins & Dallenbach (1924): sleep = less decay
      - Maybe decay isn't it.

Long-term memory

- Forgetting: underlying causes
  - Interference 

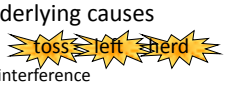
Long-term memory

- Forgetting: underlying causes
  - Interference 

    - **Retroactive** interference

Group	Learning	Interpolated	Test
Exp't'al:	**pin, herd, left**	**toss, fib, mark**	**pin, herd, toss**
Control:	**pin, herd, left**	**(…)**	**pin, herd, left**

Long-term memory

- Forgetting: underlying causes
  - Interference 

    - Retroactive interference
    - **Proactive** interference

Group	Prelearning	Learning	Test
Exp't'al:	**toss, fib, mark**	**pin, herd, left**	**pin, herd, toss**
Control:	**(…)**	**pin, herd, left**	**pin, herd, left**

Long-term memory

- Forgetting: underlying causes
  - Overwriting **tractor**
    - Actual *replacement* of one memory with another
    - Controversial

Long-term memory

- "Sleep consolidation"
  - After initial learning, slow neural changes
    - McClelland, McNaughton, O'Reilly (1995)
      - New memories may undergo repeated 'replay' after initial storage, neural changes happen gradually
      - Replays equate to spaced practice
  - REM sleep, slow-wave sleep (SWS)
  - Rats: complex training = more REM sleep
    - Procedural learning
    - Declarative may require SWS
  - Actual qualitative difference, or less to interfere?