Brain training and memory expertise

June 29, 2016
Announcements

• No class on Monday, July 4th

• Exams
  • Start reviewing for the midterm now!
  • Email me if you have a midterm or final exam conflict
  • Exit tickets and participation prompts
Homework

• Memory in Action due Tu 7/5 at 8 PM

• Brainstorm!

• When it’s really important that you remember something in the future (long-term memory), what are 2-4 specific strategies that you use to learn or study that information?

• Choose one of those strategies and *briefly* describe how you might test in the lab whether or not that strategy is effective at boosting learning?
Last Time

- **Sensory memory** is fleeting, and attentional capacity limited

- **WM capacity** is related to the ability to focus attention on relevant information and **filter out distractions**

- Behavioral and lesion data support a **distinction (double dissociation!)** between **WM** and **long term memory**

- WM “emerges” when **perceptual representations are maintained through persistent neural firing (in modality-specific regions)**

- The **prefrontal cortex** is critical for maintaining these representations (across **all** modalities)
Comparing models of WM

- short-term memory
  - temporary working memory
- control processes

- Phonological loop
- central executive
- Visuospatial sketchpad

Brain regions:
- IFJ
- FFA
- PPA

PFC
Comparing models of WM

- input
- sensory registers: visual, auditory, haptic
- short-term memory: temporary working memory, control processes
- long-term memory: permanent memory

Attention flows between sensory registers, short-term memory, and long-term memory.
Demo!
Demo!

eggs
Demo!
milk
Demo!

bread
sugar
Demo!

apples
Demo!
jelly
Demo!

hot dog
Demo!

crackers
Demo!
eggs
milk
bread
sugar
apples
jelly
bacon
vinegar
hot dog
crackers
Participation prompt!

1. Describe one time that you used working memory in the last 48 hours.

2. Where was this information maintained, according to the:
   (a) modal model
   (b) tripartite model
   (c) emergent hypothesis
This time

• Training working memory: the undergraduate SF

• How do mnemonists accomplish feats of memory?

• Do brain training programs work?
This time

• Training working memory: the undergraduate SF

• How do mnemonists accomplish feats of memory?

• Do brain training programs work?
Reminder: span tasks

• WM capacity is frequently tested with span tasks

• Digits, letters, etc.

• Example: increase the number of digits incrementally; how many digits can you remember? Try the demo on the website!

  Miller (1956): “Magic number 7, plus or minus 2”
Demonstration!
Demonstration!

Demonstration!


4 “items”: FBI-TSA-CIA-IBM

Why is this easier?
**Chunking**

- With span tasks, we evaluate **how many items** are remembered... but what is an item?

- Span increases by **increasing the number of items in a “chunk”** — this strategy is called “chunking”
  - Interplay between WM and LTM
Demonstration!
Demonstration!

12 items: L-O-L-I-R-S-H-B-O-F-D-A

↓

4 “items”: LOL-IRS-HBO-FDA
What about arbitrary information?
Can a normal person improve their WM?

- Chase & Ericsson (1981)
- SF — an undergrad with normal intelligence and a digit span of 7 items
  - Trained 1 hour per day, 3-5 days per week, for 20 months
  - More than 230 total hours of training
- How large do you think his digit span could get?
Digit span can be trained!

80 digits!
How did SF improve his digit span?

- Chunked digits into small units relating to existing knowledge
  - 349 → ‘near world record mile time’
- Developed a plan for organized (and ordered) retrieval
An organized retrieval plan

Fewer things to remember at any given time

unorganized list

organized list
An organized retrieval plan

Courtesy of Ben Levy
The trouble with transfer

- Did SF improve his working memory capacity?

- **Transfer**: generalization from one context to another (near vs. far)

- At the end of training, SF was quite average at …
  - Memorizing letter sequences (letter span)
  - Memorizing digit sequences that did not work with his strategy (digit span)

SF developed a **specific knowledge structure / strategy** that was effective for a **specific type of material** — and he used **long-term memory** to perform a **working memory task**
SF is not unique

Another subject, D.D., trained on S.F.'s strategy
SF is not unique

- World Memory Championships
- Josh Foer — a journalist — trained for a year and then won the 2006 U.S. Memory Championships
- Memorized 52 cards in 100 seconds
This time

- Training working memory: the undergraduate SF
- How do mnemonists accomplish feats of memory?
- Do brain training programs work?
Mnemonist strategies

• Largely parallel SF’s strategies
  • Link to existing knowledge structures
  • Develop an organized retrieval plan
• How will these transfer to new contexts?
Method of loci

- Ordered route of ten vivid and distinct locations
- Mentally travel through the route and imagine one item in each location
Demo!
Demo!
tacos
Demo!
carrots
Demo!

soda
Demo!

pretzels
Demo!

juice
Demo!

ice cream
Demo!

chips
grapes
Demo!

bagels
Demo!
pizza
Demo!
tacos
carrots
soda
pretzels
juice
ice cream
chips
grapes
bagels
pizza
Method of loci

• Why does it work?

• When would it not transfer very well?
Pegword system

- First learn set of pegwords
  - One = BUN
  - Two = SHOE
  - Three = TREE
  - etc
- Link each to-be-remembered item to a peg
- Similarities to method of loci?
Memorizing a deck of cards

BEN PRIDMORE
Breaking the world record in SPEED CARDS

MEMORY SPORTS.COM
Memorizing a deck of cards

https://www.youtube.com/watch?v=jmlLdYdy92k
Are mnemonists born or made?

• Memory expertise is built on normal learning processes, requires extensive practice, and does not tend to transfer

• What about ‘natural’ mnemonists?

  • Superior autobiographical memory
    ‣ Tend to have OCD-like tendencies and an unusual focus on their memories
    ‣ Unremarkable scores on standard memory tests

• Photographic memory
  ‣ Binet’s matrix
Binet’s matrix

- Asked to recall matrix in different orders

- If memory is like a photograph, recalling in any order should be equally fast

- Little evidence for true photographic memory
This time

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Evidence that ‘brain training’ software works

- Space Fortress
- Jaeggi et al. (2008)
  - Training on n-back task led to increased IQ
  - Video games linked to gains in attention
- NeuroRacer
  - Age and cognitive control

Why do we care?
Imagine that you have signed up for a new program with a company that promises to train your memory.

- What real-world benefits would you hope to gain from this training?

- How would you assess whether you are seeing these improvements?

- What type of testing would you expect the company to have done on their program?

- Who should be in charge of monitoring this company and program?
Putting brain training to the test

Adrian M. Owen\textsuperscript{1}, Adam Hampshire\textsuperscript{1}, Jessica A. Grahn\textsuperscript{1}, Robert Stenton\textsuperscript{2}, Said Dajani\textsuperscript{2}, Alistair S. Burns\textsuperscript{3}, Robert J. Howard\textsuperscript{2} & Clive G. Ballard\textsuperscript{2}
‘Brain training’, or the goal of improved cognitive function through the regular use of computerized tests, is a multimillion-pound industry¹, yet in our view scientific evidence to support its efficacy is lacking. Modest effects have been reported in some studies of older individuals²,³ and preschool children⁴, and video-game players outperform non-players on some tests of visual attention⁵. However, the widely held belief that commercially available computerized brain-training programs improve general cognitive function in the wider population in our opinion lacks empirical support. The central question is not whether performance on cognitive tests can be improved by training, but rather, whether those benefits transfer to other untrained tasks or lead to any general improvement in the level of cognitive functioning. Here we report the results of a six-week online study in which 11,430 participants trained several times each week on cognitive tasks designed to improve reasoning, memory, planning, visuospatial skills and attention. Although improvements were observed in every one of the cognitive tasks that were trained, no evidence was found for transfer effects to untrained tasks, even when those tasks were cognitively closely related.
Putting brain training to the test

2. How did the training differ for each group?
3. What are they trying to capture with these change measures?
Results: Statistics

- The dependent variable will almost never be *exactly* the same across two conditions or groups.
- Inferential statistics assess the likelihood that our observed result would have occurred if there were *truly* no difference between our conditions or groups.
  - Key idea: compare size of difference *between* groups (differences linked to our manipulation) to variability *within* groups (differences linked to random chance).
- Focus on the differences between conditions or groups that are *statistically significant*.

Which difference (A or B) do you find more convincing?
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Putting brain training to the test

In general, did the participants improve on the benchmarking scores? Did the groups differ?

Figure 1 | Benchmarking scores at baseline and after six weeks of training across the three groups of participants. PAL, paired-associates learning; SWM, spatial working memory; VSTM, verbal short-term memory. Bars represent standard deviations.
Putting brain training to the test

In general, did the participants improve on the trained tasks? Did the groups differ?

Figure 2: First and last training scores for the six tests used to train experimental group 1 and experimental group 2. The first and last scores for the control group are also shown. Bars represent standard deviations.
Putting brain training to the test

How do the authors interpret these results?

Do you agree with the authors’ interpretation of the results? Why or why not?

Describe one strength of the methods or analyses of the study.

Describe one weakness of the methods or analyses of the study, an additional question you might have wanted to see answered, or what you might do as a next step after finding these results.

Imagine your grandparent, or an older family friend, tells you they are considering enrolling in a brain training program to improve their memory, and asks for your opinion. Drawing on the findings from this article, as well as your assessment of the strengths and weaknesses of the study, what advice might you give them? Why?
General cognitive improvements?

- Other studies have also failed to find transfer effects from brain training software (e.g., Thompson et al., 2013)
  - If transfer effects exist, they are likely small
  - Have not tested all possible types of training or all measures of transfer

- The FTC recently fined Lumosity $2 million for deceptive marketing

- “A consensus on the brain training industry from the scientific community” http://longevity3.stanford.edu/blog/2014/10/15/the-consensus-on-the-brain-training-industry-from-the-scientific-community/ | see also http://www.cognitivetrainingdata.org/

  ★ “Lead physically active, intellectually challenging, and socially engaged lives”
Demo!
General summary

- Use of **specific strategies** can improve performance on **specific memory tasks** — for example, linking to existing knowledge, developing an organized retrieval plan, and practice are particularly useful.

- Little evidence for generalized memory improvements that **transfer** to other tasks.

- Growing evidence that **cardiovascular exercise** may enhance cognition more generally.
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• Choose one of those strategies and *briefly* describe how you might test in the lab whether or not that strategy is effective at boosting learning?
Questions?