

# Notes on Effective Learning

Based on  
**make it stick**

*The Science of Successful Learning*  
*Brown, Roediger & McDaniel, 2014*

April 12, 2016

*When you struggle with a problem, that's when you understand it.*

*Anyone who struggled hard with a problem, never forgets it.*

—Elon Musk  
CEO, Tesla Motors, SpaceX

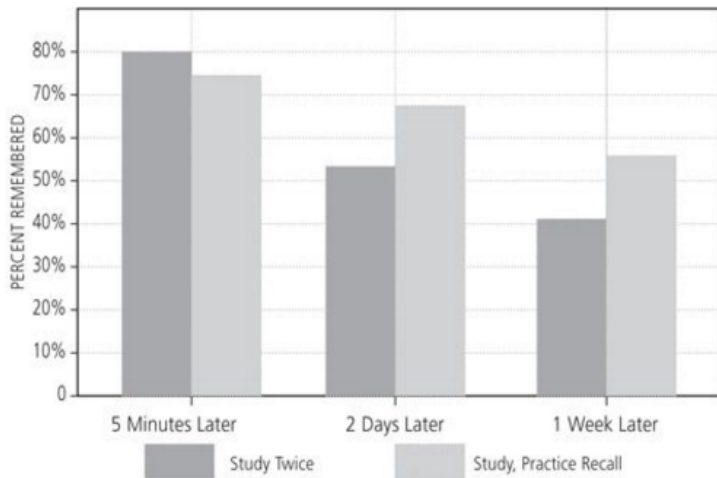
# Learning: you're doing it wrong

- Learning is best when it's *effortful*.
- We are *poor judges* of when we are learning well.
- *Rereading text* gives little benefit but leads to false sense of mastery.
- *Massed practiced*, repeating something over and over until learned, rarely works.

Which penny is real?

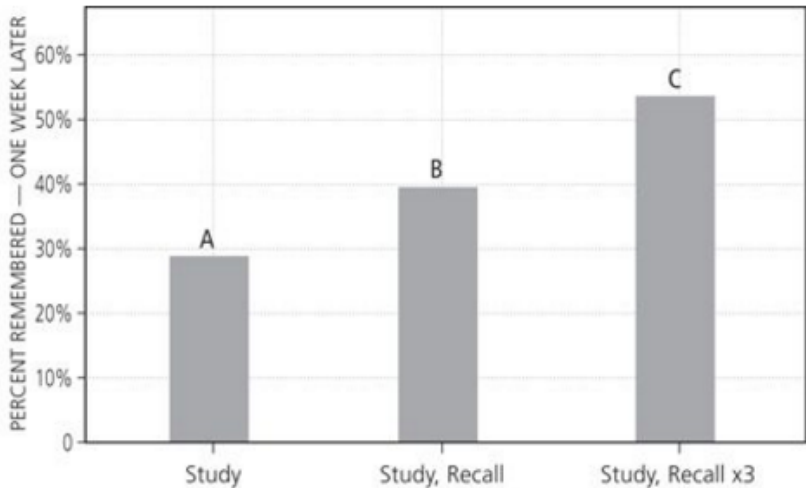


## Study vs. Testing



**TWO DIFFERENT STUDY SCHEMES (STUDY TWICE VS. STUDY + TEST)  
RECALL RESULTS AFTER FIVE MINUTES, TWO DAYS, OR ONE WEEK**

## Testing vs. More Testing



**THREE DIFFERENT STUDY STRATEGIES**  
**RECALL RESULTS, ONE WEEK LATER**

# Learning: doing it right

- *Retrieval practice* is far more effective.
- Flash cards are the simplest example.
- Trying to solve a problem yourself leads to better learning,
- ... even if you try before you know how
- ... even if errors are made

# We are all susceptible to **illusions** of learning

- Rereading or highlighting the text gives the illusion of fluency.
- **Testing** helps calibrate our judgements.
- “Shooting an azimuth.”





"Mr. Osborne, may I be excused? My brain is full."

# There is no known limit to the capacity for learning

- In 2010 Simon Reinhard memorized 300 random words in 15 minutes.
- In 2008 Ben Pridmore memorized 884 shuffled playing cards in 30 minutes.
- In 2010 Boris-Nikolai Konrad memorized 201 names and faces in 15 minutes.
- **Elaboration** is the practice of putting things in your own words and connecting it to what you already know.

# Learning changes your brain

- Every time you learn something you **change your brain**.
- The hippocampus, important in long-term memory, actually creates new neurons throughout your life.
- But only if it has to.
- When learning is hard, you're doing important work.

# The Testing Effect

- Tests: assessment vs. learning tool
- Aristotle: *exercise in repeatedly recalling a thing strengthens the memory*

## An experiment

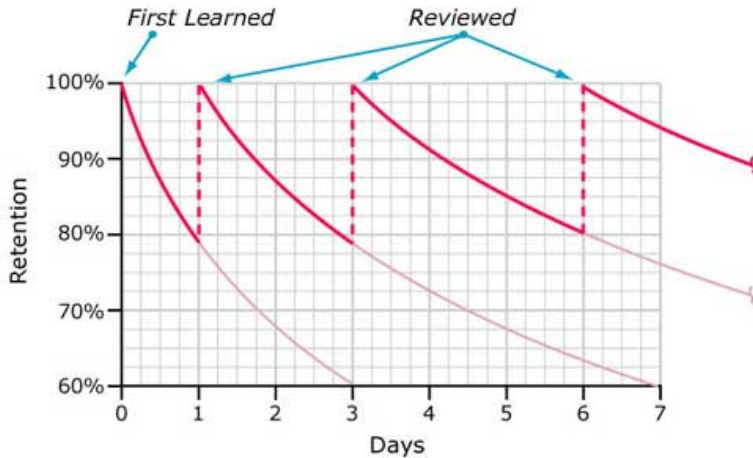
- Subjects were given passages to read.
- Some passages were immediately tested on.
- Other passages were reread.
- **Tested passages were remembered better.**

## Another experiment

- Some subjects asked to memorize pairs like *foot-shoe*
- Others asked to memorize pairs like *foot-s\_\_e*
- **Second group did substantially better.**

QUIZZING IS A LEARNING TOOL!

## Typical Forgetting Curve for Newly Learned Information





## How to practice retrieving from memory

- Quiz, quiz, quiz!
- Use flash cards: [www.ankisrs.net](http://www.ankisrs.net)
- Use Cornell note taking system  
[http://lsc.cornell.edu/LSC\\_Resources/cornellsystem.pdf](http://lsc.cornell.edu/LSC_Resources/cornellsystem.pdf)
- Look up from the book and summarize
- Invent quiz questions as you read
- Don't listen to your intuition! Shoot an azimuth!
- Space out retrieval practice, no cramming.

## Relate it to your own experience

**Generation:** Try to answer a problem before being shown the solution

**Elaboration:** Explain it in your own words and relate it to your own experience

**Reflection:** Write out essays on your learning

# CHANGE YOUR WORDS— CHANGE YOUR MINDSET

I don't understand

*What am I missing?*

I give up.

I'LL USE SOME OF THE STRATEGIES I'VE LEARNED.

I made a mistake.

Mistakes help me improve.

This is too hard.

THIS MAY TAKE SOME TIME AND EFFORT.

It's good enough.

*IS THIS REALLY MY BEST WORK?*

I'll never be as smart as her.

*I'm going to figure out what she does and try it.*

I can't make this any better.

*I can always improve; I'll keep trying!*

I can't read

*I'm going to train my brain in reading*

I'm not good at this.

*I'm on the right track.*

*We are what we repeatedly do.  
Excellence, then, is not an act, but a  
habit.*

*—Aristotle*