

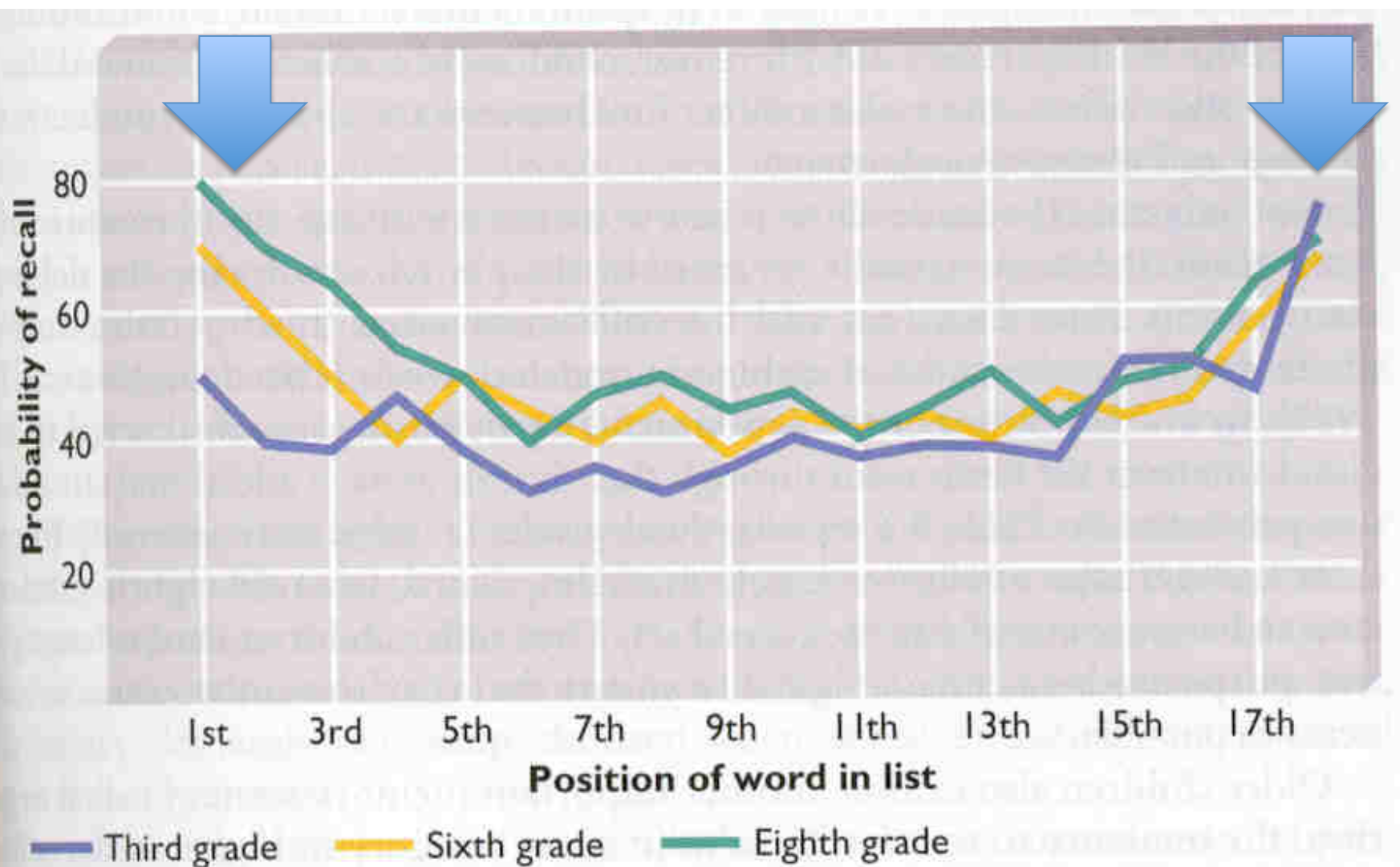
How Children Learn: The Implications of Developmental Science for Education



Overview

- Memory
- Self-regulation/executive function
- Entity versus effort beliefs

The Serial Position Curve

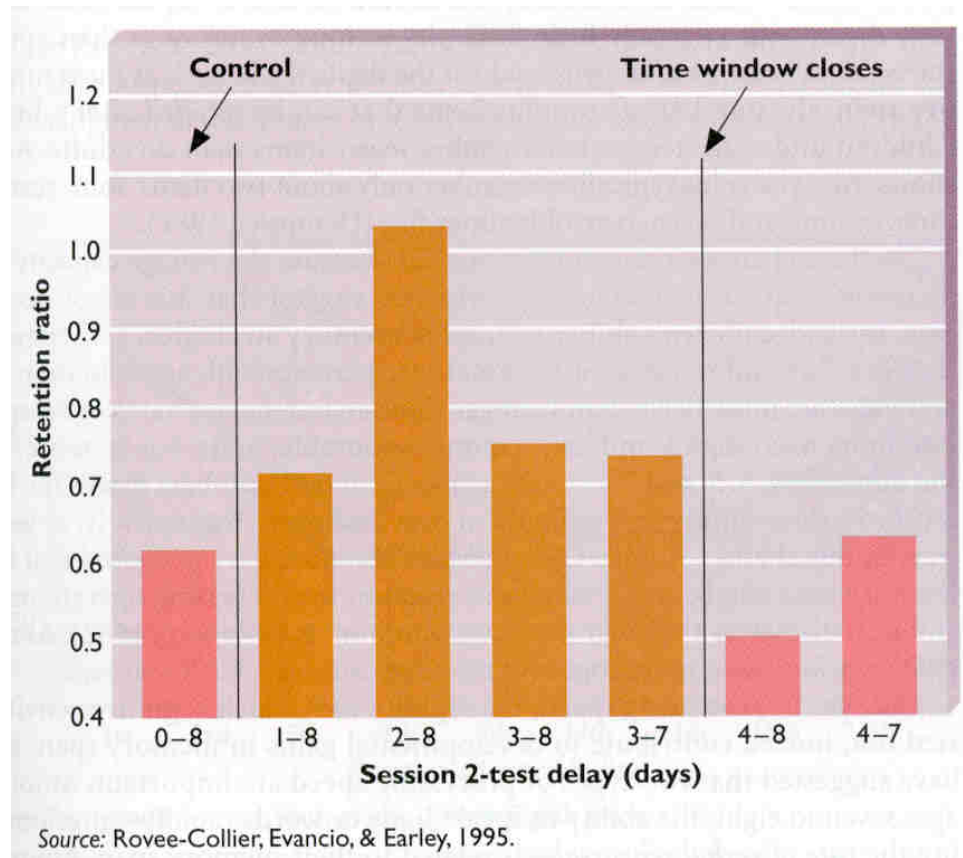


Source: Adapted from Ornstein, Naus, & Liberty, 1975.


Rovee-Collier's research with 5-month-olds

Research of
Carolyn Rovee-Collier

TIME WINDOWS



Sheffield & Hudson (1993)

- 18 mo. olds given structured task
 - Open cabinet, get fish food, feed fish in tank, put food back.
- Reminders at three different times
 - 0-0-8
 - 0-2-10  no difference
 - 0-8-16 recalled more, even 6 mos later

Recommendation 1: Space learning over time.

- Identify key concepts, terms, and skills to be taught and learned.
- Arrange for students to be exposed to each main element of material on at least two occasions, separated by a period of at least several weeks—and preferably several months.
- Arrange homework, quizzes, and exams in a way that promotes *delayed* reviewing of important course content.

Roediger & Karpicke (2006)

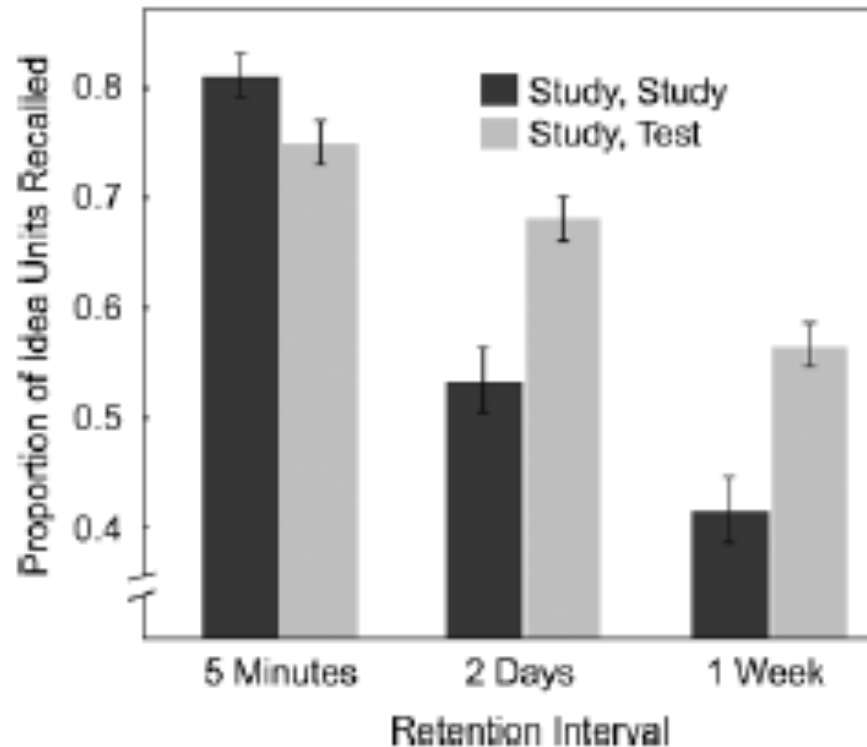


Fig. 1. Mean proportion of idea units recalled on the final test after a 5-min, 2-day, or 1-week retention interval as a function of learning condition (additional studying vs. initial testing) in Experiment 1. Error bars represent standard errors of the means.

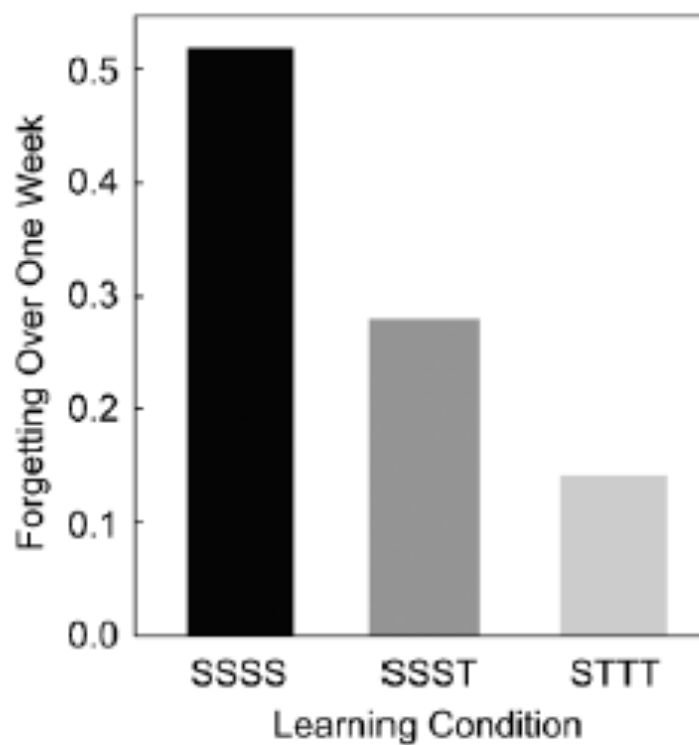


Fig. 3. Forgetting over 1 week as a function of learning condition (SSSS, SSST, or STTT) in Experiment 2. The labels for the learning conditions indicate the order of study (S) and test (T) periods.

**Recommendation 5:
Use quizzing to promote learning.**

- Prepare pre-questions, and require students to answer the questions, before introducing a new topic.
- Use quizzes for retrieval practice and spaced exposure, thereby reducing forgetting.
- Use game-like quizzes as a fun way to provide additional exposure to material.

What is self-regulation?

- Capacity to monitor, direct, and flexibly adapt one's behaviors and activities to achieve certain goals or to meet demands imposed by others.
- Forms of self-regulation:
 - Effortful control: ability to suppress undesirable responses for less dominant ones.
 - Delay of gratification: capacity to wait before performing a tempting activity.
 - Executive function: ability to control one's own cognitive processes.

Executive function includes:

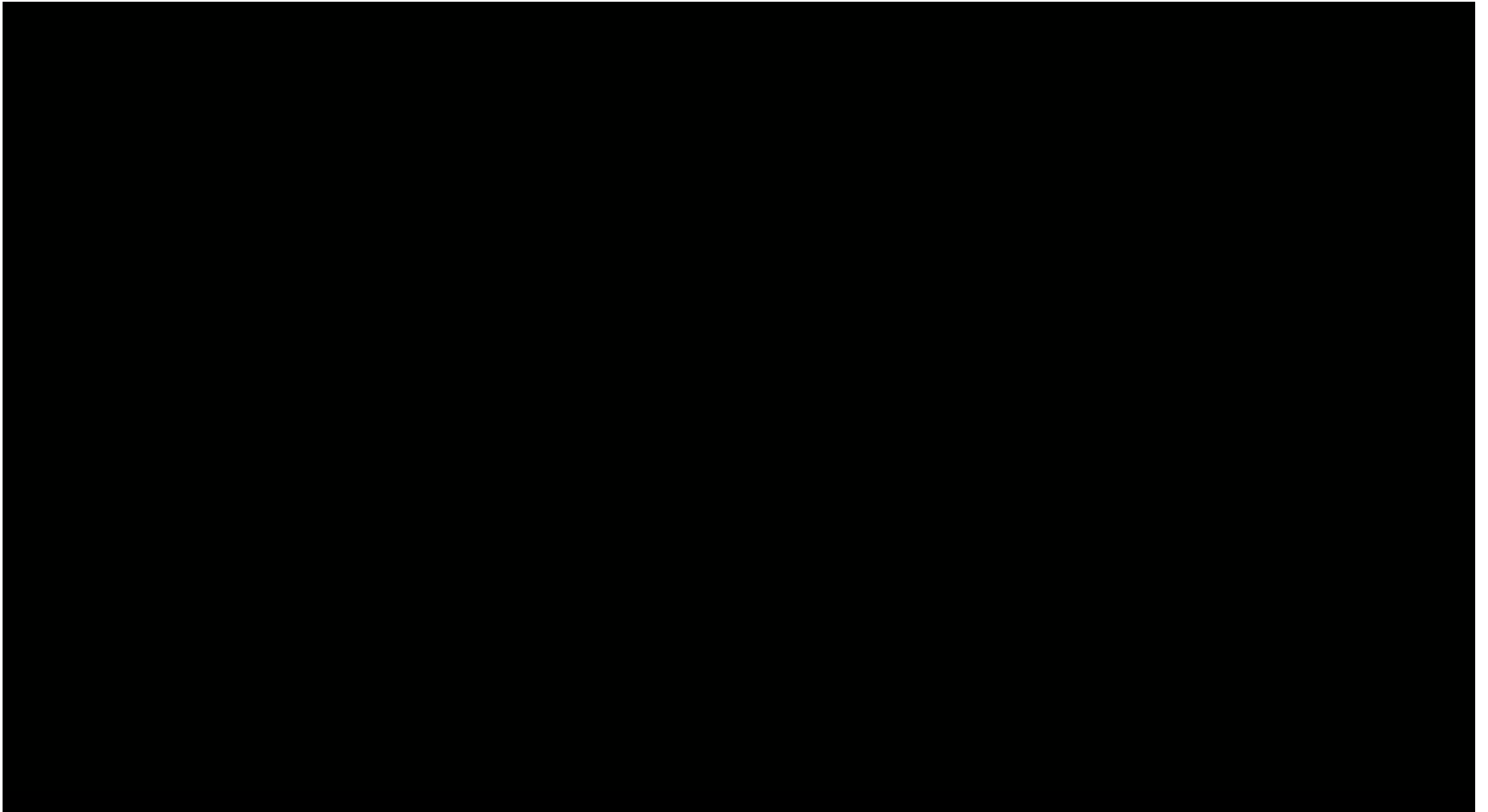
- planning
- cognitive flexibility
- inhibiting action (including *prepotent responses*)
- attention

As parents and teachers, we usually want to see high self-regulation in children in all of its forms. This is an important developmental goal.

How do we measure self-regulation?

- Delay of gratification
- Cognitive tasks
 - Stroop Task
 - Go/No Go Task
 - Wisconsin Card Sorting Task

The Marshmallow Test (Mischel, 1972)



Stroop Task

| | | | | | |
|-------|-------|-------|-------|-------|-------|
| red | blue | green | red | black | red |
| black | red | black | black | blue | green |
| black | green | red | red | green | black |
| black | blue | black | red | red | blue |
| blue | black | blue | red | green | green |
| green | red | green | blue | blue | blue |
| blue | green | black | blue | black | red |
| blue | red | green | green | green | black |

Why does it self-regulation matter?

It predicts a lot!



What does all of this have to do with academic achievement?

Duncan et al. (2007): Skills in preschool that predict academic success in Grade 3 and beyond

Table 3

Average Correlations and Meta-Analytic Regression Results for the Standardized Coefficients From the Six Data Sets

| Independent variable | Zero-order correlation coefficients | Most recent reading and math outcomes | Reading and math | All observed outcomes | |
|--|-------------------------------------|---------------------------------------|------------------|-----------------------|--------------|
| | | | | Reading | Math |
| School-entry measure | | | | | |
| Reading | .44 | .13*** (.01) | .17*** (.03) | .24*** (.03) | .10*** (.02) |
| Math | .47 | .33*** (.06) | .34*** (.04) | .26*** (.02) | .42*** (.04) |
| Attention skills | .25 | .07* (.02) | .10*** (.01) | .08*** (.02) | .11*** (.02) |
| Externalizing problems | -.14 | .01 (.00) | .01 (.01) | .01 (.02) | .01 (.01) |
| Internalizing problems ^a | -.10 | — | — | — | — |
| Social skills | .21 | -.01 (.01) | -.01 (.01) | -.00 (.02) | -.01 (.01) |
| Time (years between school entry measure and outcomes) | | -.010*** (.001) | -.009 (.005) | -.012** (.005) | -.005 (.005) |

Duckworth & Seligman (2005): Factors that predict academic performance in 8th graders

TABLE 2

Intercorrelations Between Academic-Performance Indicators and Composite Self-Discipline

| Academic-performance variable | Study 1 (<i>N</i> = 140) | Study 2 (<i>N</i> = 164) | |
|-------------------------------|---------------------------|---------------------------|--------|
| | Self-discipline | Self-discipline | IQ |
| First-marking-period GPA | .52*** | .66*** | .34*** |
| Final GPA | .55*** | .67*** | .32*** |
| Spring achievement test | .29** | .43*** | .36*** |
| Selection to high school | .42*** | .56*** | .26** |
| School absences | -.17* | -.26** | -.07 |
| Homework hours | — | .35*** | -.09 |
| Television hours | — | -.33*** | -.06 |
| Time of day homework is begun | — | -.26** | .18* |

Note. GPA = grade point average.

p* < .05. *p* < .01. ****p* < .001.

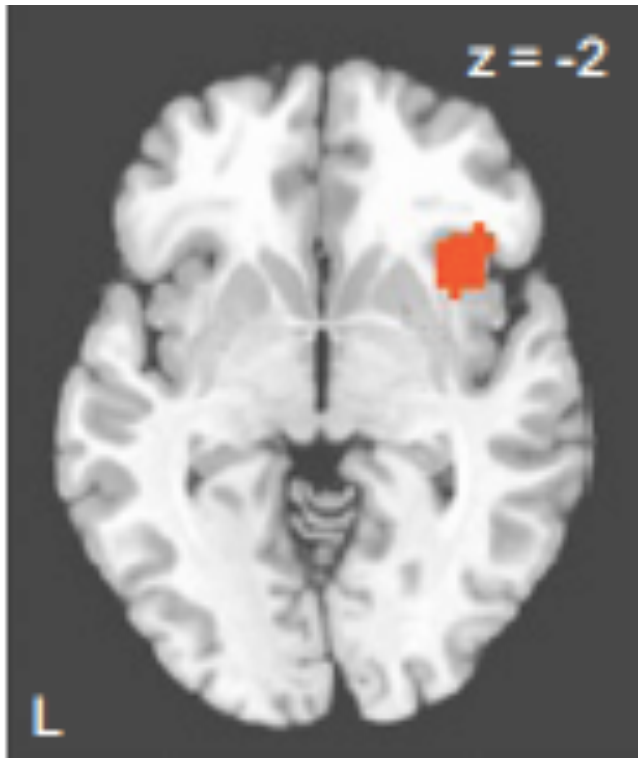
Is self-regulation an inborn characteristic?

- Rothbart (2005): Some children show differences in temperament:
 - (1) **reactivity**
 - (2) **self-regulation**, right from infancy



What happens 40 years later? (Casey et al., 2011)

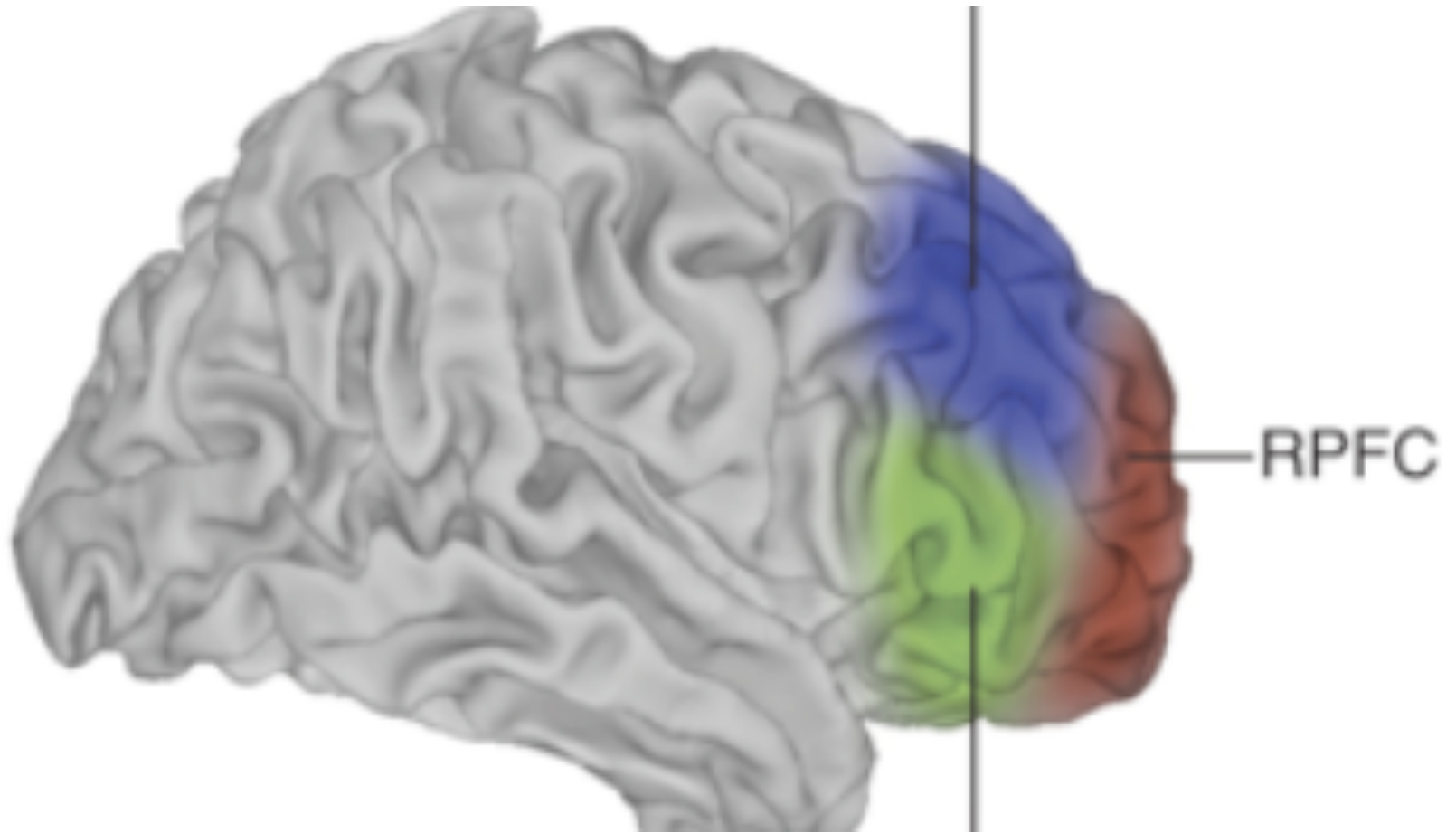
High delayers: active frontal cortex



Low delayers: active ventral striatum



Brain science: significant development in prefrontal cortex up through adolescence



“Myelinization”

Can self-regulation (EF) be trained?

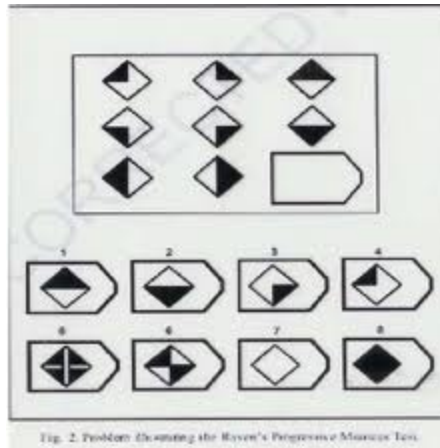
- Posner, Rothbart, & Rueder (2005): YES
 - 4- and 6-year-olds trained on Stroop, mazes, tracking a cat moving on a computer
 - 5 days of training over 2 to 3 weeks
 - Executive attention and IQ scores increased

Self-regulation and metacognition

- Have I studied enough? Have I mastered this concept?
- What should I do if I have not mastered the material?
- What is the best way for me to study?
- What kinds of questions should I ask the teacher?

Entity versus Incremental Views of Intelligence (Dweck)

PHASE 1: Raven Progressive Matrices



2: MANIPULATION:

“You must be smart at these problems.” (ENTITY)

“You must have work hard at these problems.” (INCREMENTAL)

3: MEASURE ACHIEVEMENT GOALS

Children in the second group were more likely to select challenging problems and showed greater task persistence.

“You Can Grow Your Brain”

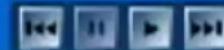
Table 2

Summary Chart: Intervention Protocol

| Sessions | Experimental group | Control group |
|----------|--|---|
| 1 and 2 | <i>The Brain—Structure & Function: Brain Anatomy, Localization of Function, Neuronal Structure, Neurotransmission</i> | <i>Same as experimental group</i> |
| 3 and 4 | <i>Incremental Theory Intervention Reading (aloud in class): “You Can Grow Your Intelligence” Activity: “Neural Network Maze,” showing how learning makes your brain smarter</i> | <i>Alternative Lesson: Memory Reading (aloud in class): “Memory” Activity: “Grocery Store Tricks,” teaching mnemonic strategies</i> |
| 5 and 6 | <i>Anti-Stereotyping Lesson: Slides, activity, discussion to illustrate the pitfalls of stereotyping. Study Skills Lesson: Slides, lecture, discussion, handouts teach time management and study skills.</i> | <i>Same as experimental group</i> |
| 7 and 8 | <i>Discussions: Learning makes you smarter; Labels (e.g., stupid, dumb) should be avoided</i> | <i>Discussions: Academic difficulties and successes, preferences; Memory and the brain</i> |

<http://www.brainology.us/>

Brainology® **demo**



Control Panel



e-Journal



Notepad
(e-Journal
Reflector)



Map



Brain book



Help



Feedback



Save & Exit



Welcome to

Brainology®



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Two additional important points

Recommendation 2: Interleave worked example solutions with problem-solving exercises.

- Have students alternate between reading already worked solutions and trying to solve problems on their own.
- As students develop greater expertise, reduce the number of worked examples provided and increase the number of problems that students solve independently.

Recommendation 7: Ask deep explanatory questions.

- Encourage students to “think aloud” in speaking or writing their explanations as they study; feedback is beneficial.
- Ask deep questions when teaching, and provide students with opportunities to answer deep questions, such as: *What caused Y? How did X occur? What if? How does X compare to Y?*
- Challenge students with problems that stimulate thought, encourage explanations, and support the consideration of deep questions.

Some Excellent Resources

"What Works Clearinghouse"

<http://ies.ed.gov/ncee/wwc/>

"Doing What Works"

<http://dww.ed.gov/>

"American Psychological Association"

<http://www.apa.org/education/k12/curricular-materials.aspx>