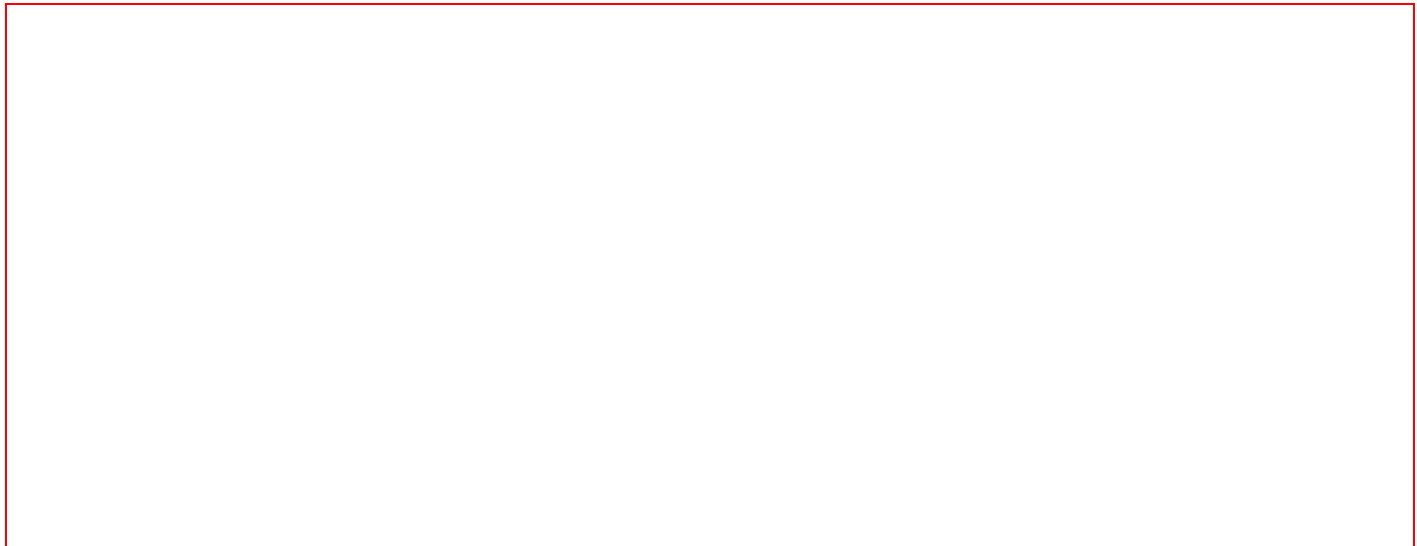


The Role of the Executive Functions in STEM Learning



Importance of Preschool Numeracy



Alternative interpretations

- Early developing numeracy skills have a causal role in success at mastering STEM material.
- Maybe—but alternatives?

Alternatives

- Smart is smart.
- Parents who teach children to count, play number games with them, also support later educational success.
- **HOW RULED OUT (not whole story)**
- **LESSON 1. MUST MAKE NUMERACY AN EQUAL FOCUS WITH PRELITERACY IN PRESCHOOL**

EF, Frontal Lobe Function



Mischel's Marshmallow Studies

Walter Mischel Marshmallow experiment

Average wait between 7 and 8 minutes, range
0 to 15 minutes

EF is Important to Educational Outcomes

- How long children waited at age 4 predicts:
- SAT scores at age 18, income at age 30, likelihood of ever having been arrested at age 40.
- Measures of EF at age 4 the best predictors of school readiness at age 5.
- Measures of EF at every age the best predictors of school success at that age.

Executive Function Development

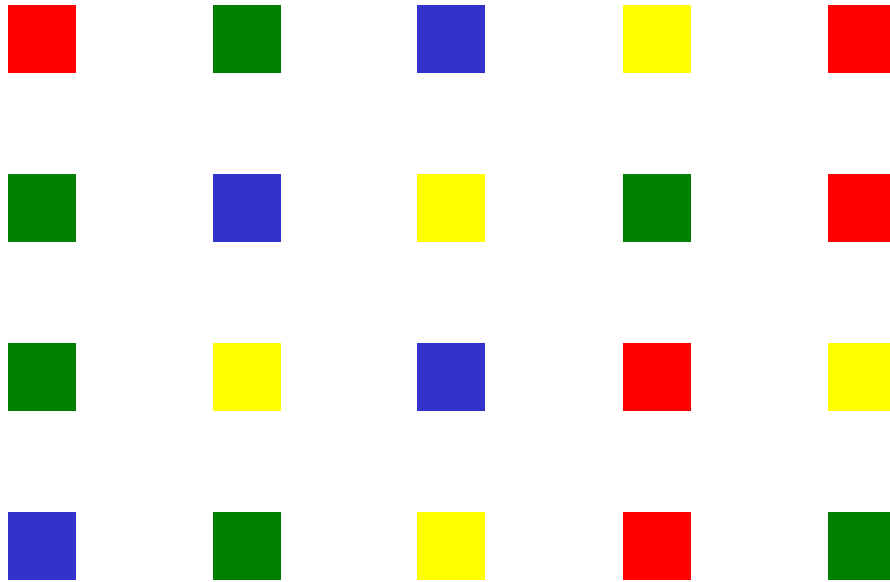
- Domain general capacities that underlie the human capacity for flexibly deploying their cognitive resources in thought and action.
- Inhibition (self control)
- Cognitive Conflict Resolution (cognitive control)
- Working Memory
- Set Shifting

- Inhibition—resisting the temptation to eat the slice of cake now to serve the goal of staying thin.
- Also, prepotent response inhibition (e.g., Stroop task)

STROOP

RED GREEN BLUE YELLOW RED
GREEN BLUE YELLOW GREEN RED
GREEN YELLOW BLUE RED YELLOW
BLUE GREEN YELLOW RED GREEN

STROOP



STROOP

RED GREEN BLUE YELLOW RED
GREEN BLUE YELLOW GREEN RED
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Working Memory

- E.g., backward digit span. (Hold items in working memory and also manipulate them).

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Set shifting

- Hierarchical rules—e.g., if capital letters, name the font color; if lower case, read the word.
- Practice:

RED

yellow

STROOP

RED blue yellow RED GREEN

blue yellow GREEN RED green

YELLOW blue red YELLOW

BLUE green yellow red GREEN

Frontal Lobe (neocortex)

- The seat of EF. (Lesions to the frontal lobe impair EF; imaging studies show frontal lobe to be active in tasks that are heavy in EF demands).
- Frontal lobes latest to mature in childhood; maturation continues through adolescence
- More highly developed in humans than other primates.

Stable

- Measures of different aspects of EF correlate with each other at a given point in development.
- Measure of EF at time 1 correlate with measures at time 2, even years apart.

EF development

- Continues throughout childhood
- Stable individual differences in EF capacity
- Individual differences in EF very important to many different outcomes in life!
- Including STEM learning

Importance for STEM Learning

- Concurrent measures predict:

Teacher ratings of school readiness

Performance on standardized tests of STEM learning at every age—preschool thru 12th grade

Prospective Studies

- E.g., measure EF, numeracy skills at beginning of Pre-K year.
- What predicts mastery of arithmetic skills at the end of K, controlling for IQ, parental education, SES?

Pre-K numeracy measures

Also, pre-K EF measures, even after controlling for numeracy, IQ, SES.

Why Might EF play a role in STEM Learning?



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- High EF, supports, staying on task, controlling attention, better social relations (with teachers, with peers)

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- High EF, supports, staying on task, controlling attention, better social relations (with teachers, with peers)
- All of the above. But deeper cognitive reason as well—needed for conceptual change.

Theory 1

- Animal/people: Fundamentally intentional/causal agents
- “Alive” = active/real/existing
- “Dead” = opposite of life. Not active/real/existing
- Body supports intentional action. Internal organs—one organ-one function.

Vitalist Biology

People/Animals. Living things (which now includes plants as well).

Alive = reproduces, grows, eats...

Dead = end of life cycle

Bodily function = system supporting biological goals (growth, health).

The Study.

- EF battery
- Vitalist Battery
 - animism interview
 - death interview
 - bodily function interview

Results

