

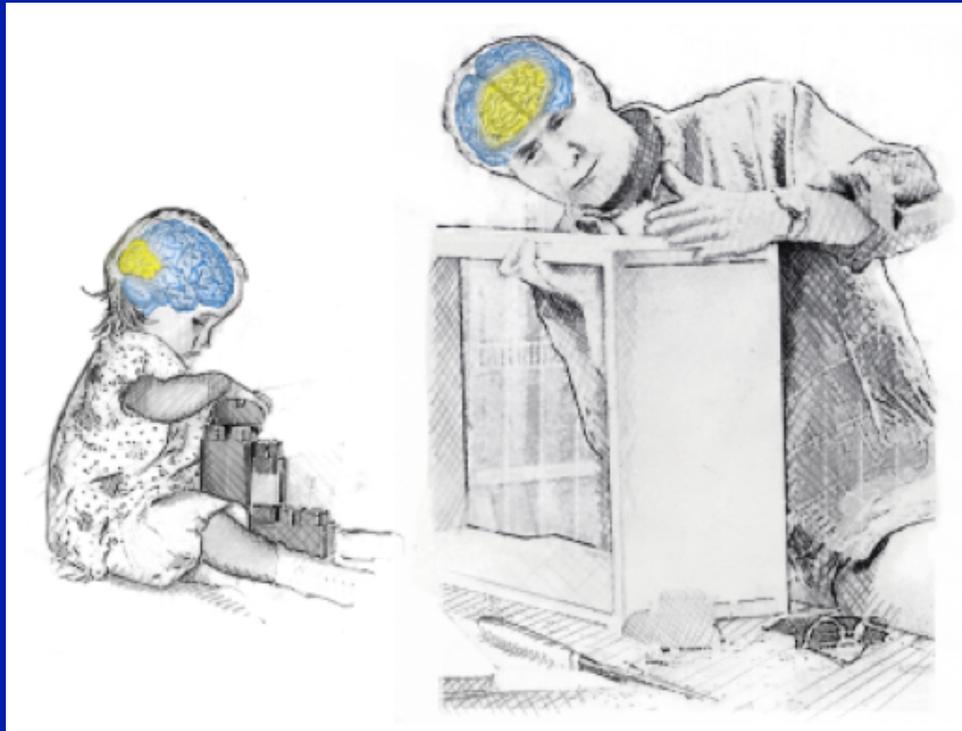
Interactions between Executive Functions and Learning

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Executive Function Development

(Munakata, Snyder, & Chatham, 2012)



(Thompson-Schill et al., 2009)

- Broad range of cognitive processes supporting goal-directed behavior
- Reactive, habitual, exploratory -> Proactive, flexible, task-driven
- Working memory, inhibitory control, abstraction
- Posterior -> Prefrontal

EF and Learning

- Advances
 - Early EF predicts learning, long-term outcomes
 - EF can be changed through learning
- Challenges
 - EFs are complex, involve trade-offs, can impair learning
 - Attempts to improve EF are not fully understood

Early EF Predicts Outcomes

(Diamond, 2012)

- Preschool delay of gratification predicts adolescent academic performance and social competence (Mischel et al., 1989)
- Childhood self-control predicts health, wealth, criminality in adulthood (Moffitt et al., 2011)
- Preschool inhibitory control predicts math and reading ability in kindergarten (Blair & Razza, 2007)
- Independent of IQ, SES, etc. so interpreted as EF supporting learning

EFs Can Be Changed

(Miyake, Alexander, Altamirano, Barker, Chevalier, Gustavson, Lurquin, Michaelson, Rieter, & Munakata, in prep)

- **EF Training**
 - Working memory (Melby-Lervag & Hulme, 2012)
- **Preschool Interventions** (Diamond, 2012)
 - Tools of Mind, Montessori, Project REDI
- **Self-Regulation Training**
 - Focusing on real-world control (e.g., avoiding swearing, improving posture, emotional conduct)
- **Physical Fitness Training**
- **Mindfulness Meditation Training**

EF and Learning

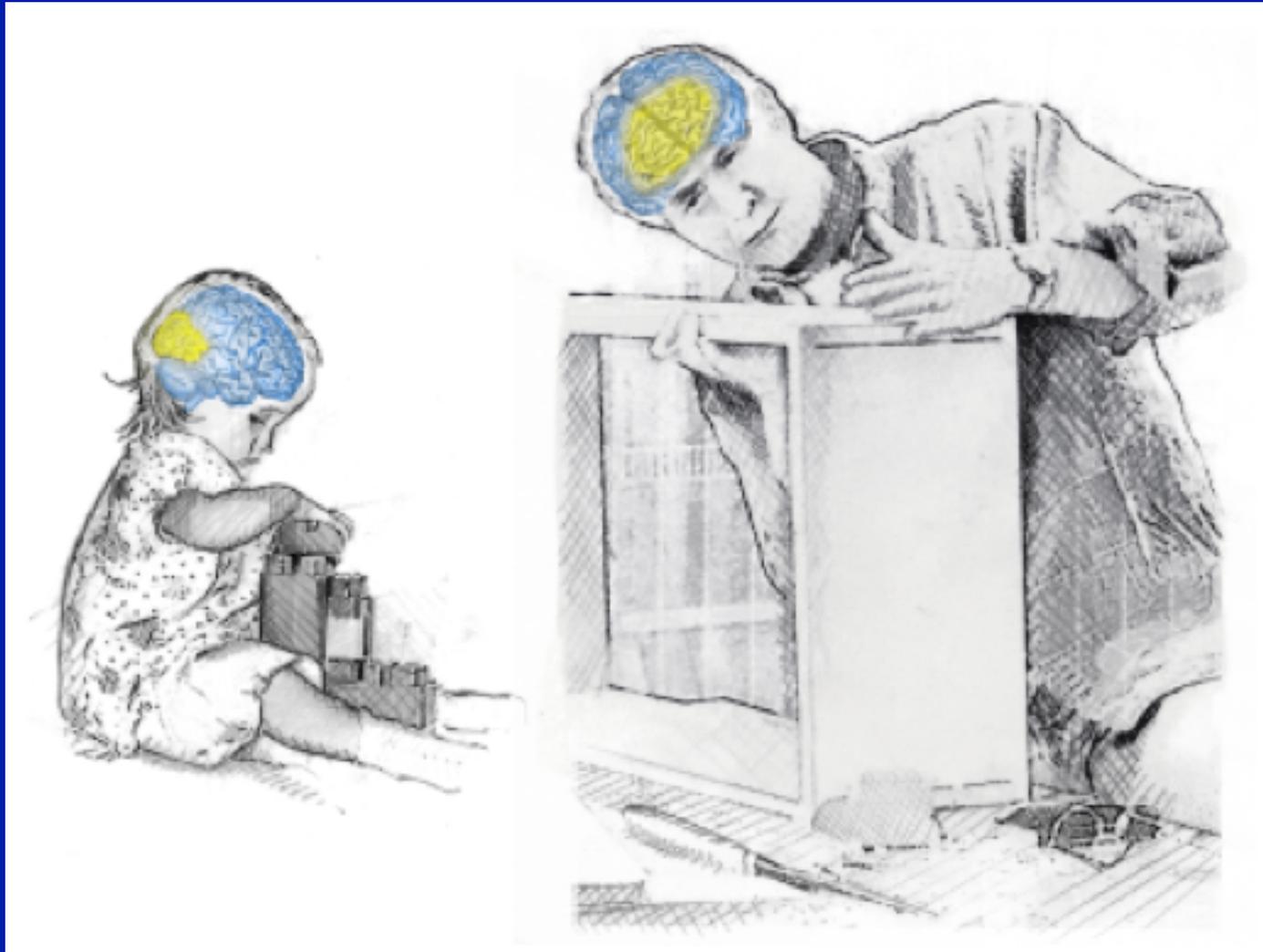
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How EFs Impact Learning

- Generally viewed as adaptive, associated with positive outcomes
- But, relationships with and among EFs complex, can see tradeoffs
 - Maintain goals vs. flexibly shift (Goschke, 2000)
 - More restrained preschoolers in “Don’t Touch” task show better Common EF but *worse* shifting-specific EF (Friedman et al., 2011)
 - Some aspects of EF may impair learning

EF Can Impair Learning

(Thompson-Schill et al., 2009)



EF Can Impair Learning

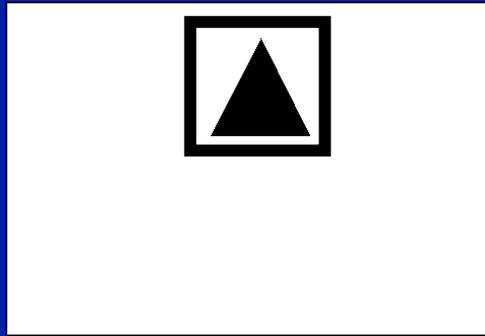
- Top-down goals can interfere with learning of statistical regularities
 - Developmentally: Children maximize, while adults probability match (Derks & Paclisanu, 1967; Thompson-Schill et al., 2009)
 - Individual differences: Higher working memory -> more susceptibility to confirmation bias (Doll, Hutchison, & Frank 2011)
 - Polymorphism in dopaminergic genes: Rare advantage to COMT Val/Val genotype over Met₉ allele carriers

EF Dev Can Impair Retrieval

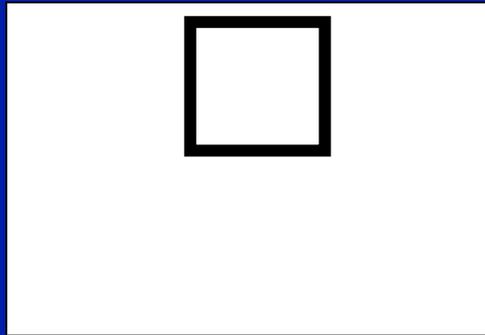
(Blackwell & Munakata, under revision)

- Reactive -> proactive control (Chatham et al., 2009)
 - Engaging control as needed vs. in advance
 - Benefits in preparedness: Proactive children faster than reactive children on delayed-match-to-sample

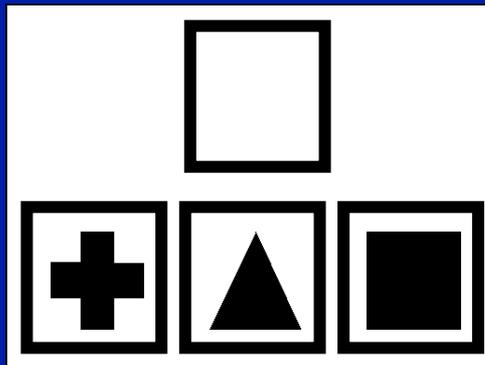
Proactive Strategies



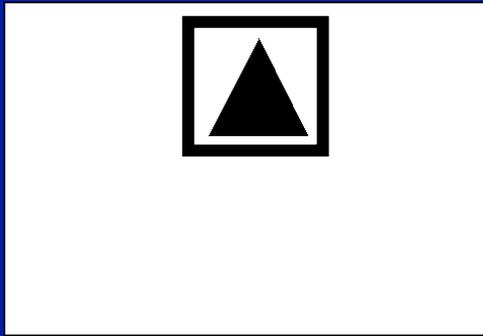
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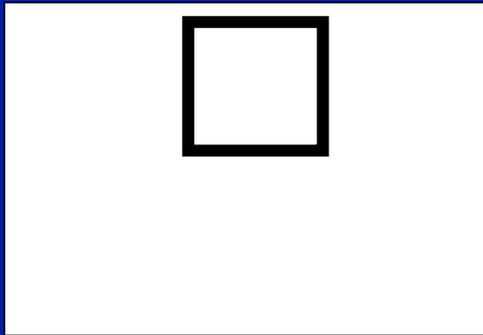
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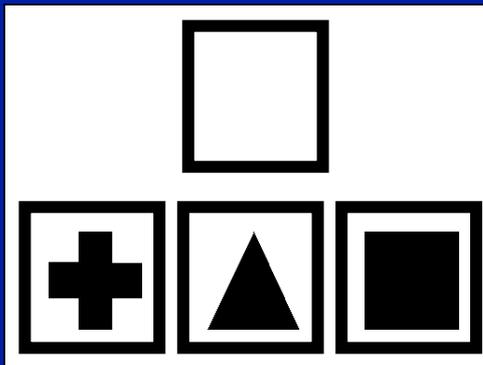
No Visible Strategies



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EF Dev Can Impair Retrieval

(Blackwell & Munakata, under revision)

- Reactive -> proactive control (Chatham et al., 2009)
 - Engaging control as needed vs. in advance
 - Benefits in preparedness: Proactive children faster than reactive children on delayed-match-to-sample
 - Costs in retrieval: Proactive children slower than reactive children on delayed-match-to-sample with distraction

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EF Interventions

- Some multifaceted and time-intensive
 - Hard to isolate critical components
 - Preschool interventions (Tools of the Mind: spans 1-2 years across play/eating/naps, pretend play, private speech, attn aids)
- More targeted show limited transfer
 - Working memory (Melby-Lervag & Hulme, 2012)
- Some show limited success
 - Inhibitory control (Thorell et al., 2009)

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Opportunities

- Investigate basic mechanisms of executive functions and learning
 - Address complexity, diverse components, trade-offs
 - Computational models as useful tool, and can help to bridge brain-behavior, provide unified framework
 - Frontostriatal mechanisms in EF components and learning (Frank & O'Reilly, 2006)

Opportunities

- Systematic and theory-driven tests of effects of experience
 - On diverse EF components (e.g., shifting, updating, Common EF)
 - And non-EF processes
 - Which aspects of EF help/hurt learning, which aspects of learning, at what time points/scales
 - Build on well-specified theories and models

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