ABCD: Neurocognitive Assessments

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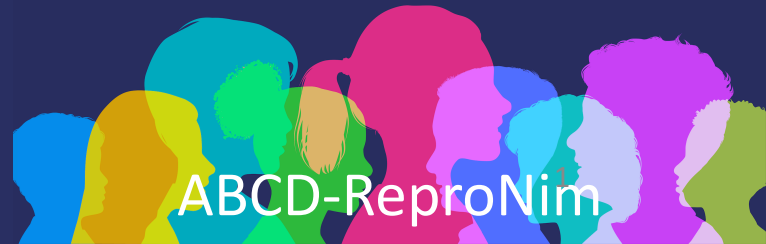


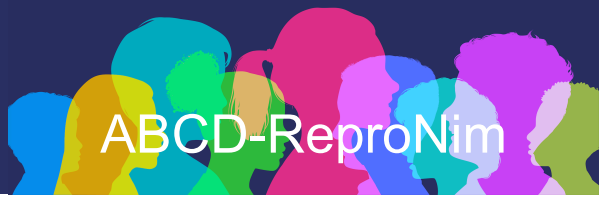
Learning Objectives of this Lecture

- Identify goals of the ABCD Neurocognition Battery
- Summarize types of measures in ABCD Neurocognition Battery
- Summary of methodological considerations in administering the measures

Description and Rationale of Neurocognitive Battery

- **Goals:**
  - Examine typical developmental changes
  - Capture altered trajectories due to substance use, new mental health symptoms, and other emergent factors
  - Mainly repeatable tasks (robust to retesting or have alternate forms)
  - A few less traditional assessments (e.g., hot cognition), including some with “aha” moments (administer only once)
- **Tasks that:**
  1. facilitate comparisons with other large studies (e.g., NIH Toolbox)
  2. maximize sensitivity to development and emergent factors across 10 years of assessment, starting at ages 9-10
  3. computerized (maximize efficiency for a large multi-site study)
  4. minimize participant burden

Measures in ABCD Neurocognition Battery



General Ability/ Intelligence

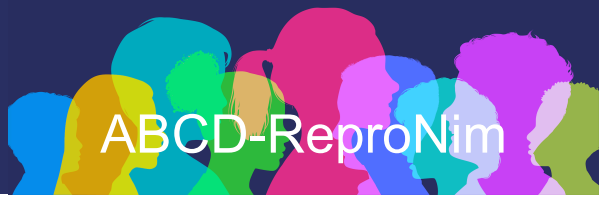
Learning/ Memory

Executive functioning / Cognitive Control

Reward

		BL	1yr fu	2yr fu	3yr fu	
Task:	**Platform:**	**9-10**	**10-11**	**11-12**	**12-13**	**Purpose:**
Picture Vocabulary	NIH Toolbox	x		x		Receptive vocabulary, general intellect
Oral Reading Recognition	NIH Toolbox	x		x		Reading decoding skill, general intellect
Matrix Reasoning	Q-Interactive	x				Visual processing and abstract, spatial perception
Little Man Task	Millisecond	x		x		Visuospatial functioning, mental rotation
Stanford Mental Arithmetic Response Time Eval	Millisecond				x	Math achievement and fluency
List Sorting Working Memory	NIH Toolbox	x				Working memory
Picture Sequence Memory	NIH Toolbox	x		x		Episodic memory
Rey Auditory Verbal Learning Test	Q-Interactive	x		x		Verbal learning and memory
Dimensional Change Card Sort	NIH Toolbox	x				Cognitive flexibility and attention
Pattern Comparison Processing Speed	NIH Toolbox	x		x		Speed of processing
Flanker Inhibitory Control and Attention	NIH Toolbox	x		x		Attention and inhibitory control
Emotional Stroop	Millisecond		x		x	Inhibition of prepotent responses, affective regulation
Game of Dice Task	Millisecond			x		Aversion/attraction to risky decisions
Stop Signal fMRI task	E-Prime	x		x		Impulsivity and impulse control
Emotional N-back fMRI task	E-Prime	x		x		Working memory, emotion reactivity and regulation
Social Influence Task	Millisecond			x		Social influence and risk perception
Cash Choice	REDcap	x				Discounting of proximal and distal rewards
Delay Discounting	Millisecond		x		x	Discounting of proximal and distal rewards
Monetary Incentive Delay fMRI task	E-Prime	x		x		Reward processing and motivation

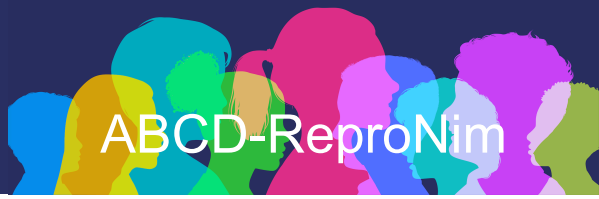
Measures in ABCD Neurocognition Battery



- 3 broad components, shown using a PCA model, for 11 tasks used at Baseline
  - General Ability / Intelligence
    - Picture Vocabulary
    - Oral Reading Recognition
    - Little Man Task
  - Executive Function / Cognitive control
    - Flanker
    - Dimensional Change Card Sort
    - Pattern Comparison Processing Speed
  - Learning/Memory
    - List Sorting Working Memory
    - Picture Sequence Memory
    - Rey Auditory Verbal Learning Test

Thompson et al., 2019, DCN

Variations in Assessments Across Time Points



- Covers multiple domains, adds measures of "hot" cognition, and minimizes participant burden
- Some tasks key for scan years

		BL	1yr fu	2yr fu	3yr fu	
Task:	**Platform:**	**9-10**	**10-11**	**11-12**	**12-13**	**Purpose:**
Picture Vocabulary	NIH Toolbox	x		x		Receptive vocabulary, general intellect
Oral Reading Recognition	NIH Toolbox	x		x		Reading decoding skill, general intellect
Matrix Reasoning	Q-Interactive	x				Visual processing and abstract, spatial perception
Little Man Task	Millisecond	x		x		Visuospatial functioning, mental rotation
List Sorting Working Memory	NIH Toolbox	x				Working memory
Picture Sequence Memory	NIH Toolbox	x		x		Episodic memory
Rey Auditory Verbal Learning Test	Q-Interactive	x		x		Verbal learning and memory
Dimensional Change Card Sort	NIH Toolbox	x				Cognitive flexibility and attention
Pattern Comparison Processing Speed	NIH Toolbox	x		x		Speed of processing
Flanker Inhibitory Control and Attention	NIH Toolbox	x		x		Attention and inhibitory control
Stop Signal fMRI task	E-Prime	x		x		Impulsivity and impulse control
Emotional N-back fMRI task	E-Prime	x		x		Working memory, emotion reactivity and regulation
Cash Choice	REDcap	x				Discounting of proximal and distal rewards
Monetary Incentive Delay fMRI task	E-Prime	x		x		Reward processing and motivation
Delay Discounting	Millisecond		x		x	Discounting of proximal and distal rewards
Emotional Stroop	Millisecond		x		x	Inhibition of prepotent responses, affective regulation
Game of Dice Task	Millisecond			x		Aversion/attraction to risky decisions
Social Influence Task	Millisecond			x		Social influence and risk perception
Stanford Mental Arithmetic Response Time Eval	Millisecond				x	Math achievement and fluency

NIH Toolbox: Cognition Domain

- Comprehensive set of neurobehavioral tests
- Cognition Battery measures: Language, Attention, Episodic Memory, Working Memory, Executive Function, and Processing Speed
- Originally developed for web, adapted for iPad app-based administration
- Developed to facilitate longitudinal measurement from age 3 through the lifespan
- 7 tasks, ~35 minutes to administer
- Raw, age-standardized, and demographics-corrected T-scores

Q-Interactive

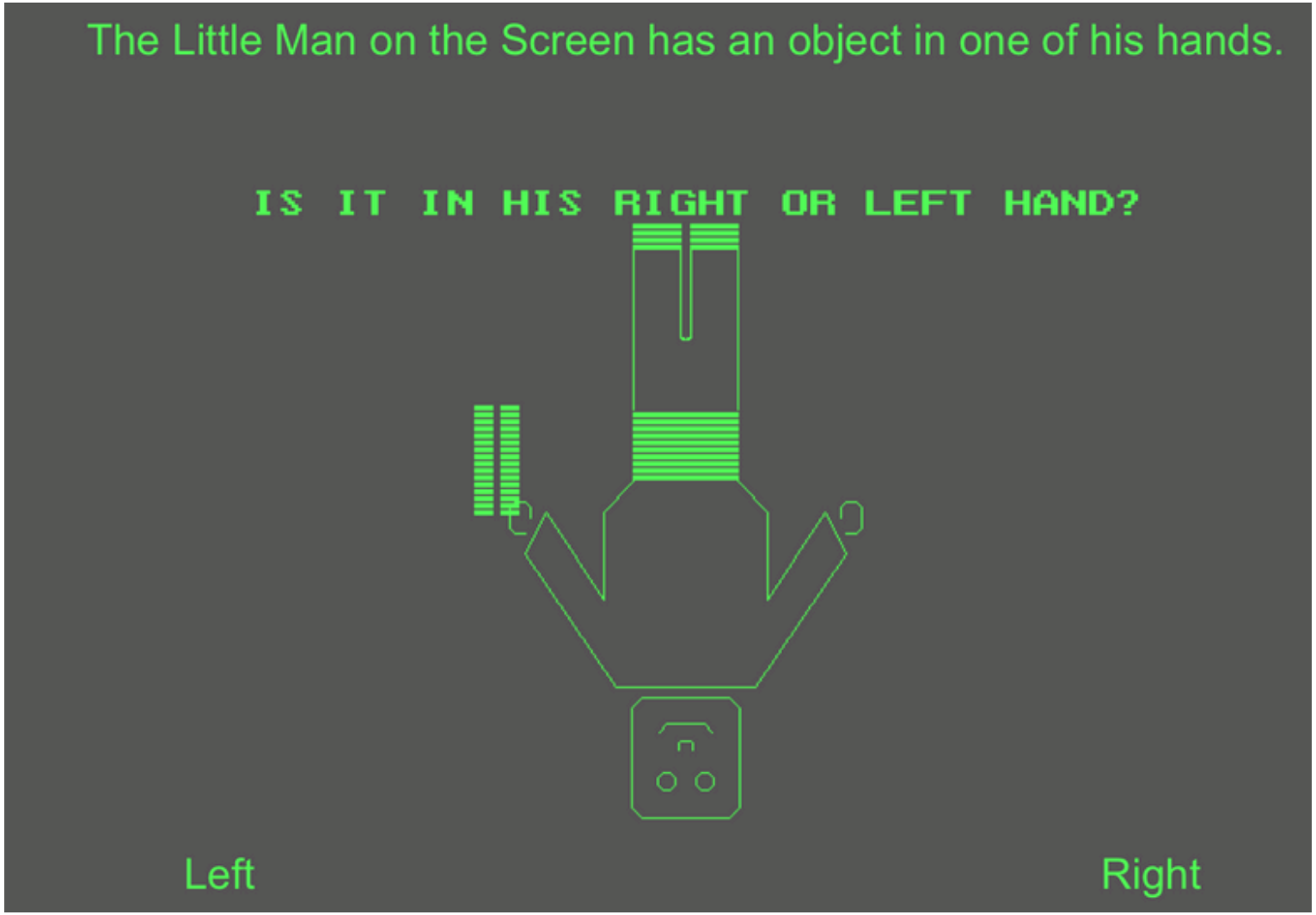
- Rey Auditory Verbal Learning Task
  - Alternate word lists for each repeated time point
  - 16 minutes to administer, with a 30-minute delay period
  - Performance and errors on learning and recall trials

- WISC-V Matrix Reasoning
  - 8 minutes
  - Raw and standardized scores

www.PearsonAssessments.com
Vakil et al., 2012. Child Neuropsychology
Daniel et al., 2014, WISC®–V: Q-Interactive Technical Report 8

Little Man Task

- Mental rotation task
  - ~6 minutes
  - Engaging
  - Developed for ABCD by Millisecond using Inquisit platform
- Measures accuracy and reaction time



https://www.millisecond.com/download/library/mentalrotation/abcdlittlemantest/
Picazio 2013, PLoS ONE

Cash Choice & Delay Discounting

ABCD-ReproNim

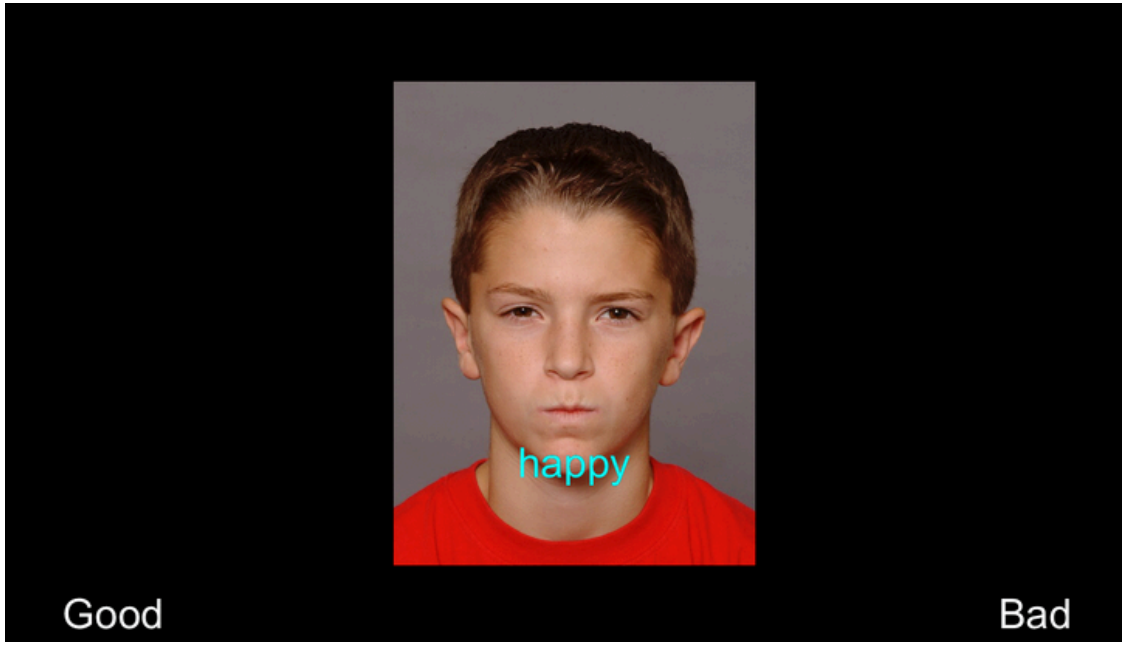
- **Cash Choice** (baseline only):
  - "Let's pretend a kind person wanted to give you some money. Would you rather have
    - **$75 in 3 days, or**
    - **$115 in 3 months"**
- **Delay Discounting**
  - ~3 minutes
  - Developed for ABCD by Millisecond using Inquisit platform
  - Provides Indifference Points for 7 delays tested, and RTs

https://www.millisecond.com/download/library/delaydiscountingtask/abcddelaydiscounting/

Koffarnus & Bickel, 2014. Exp. Clin. Psychopharmacology.

Emotional Stroop

- ~9 minutes
- Developed for ABCD by Millisecond using Inquisit platform
- Categorize words as "good" (happy, joyful) or "bad" feeling (angry, upset), while screen shows word-congruent or incongruent emotion face.
- Blocks:
  1. 25% incongruent and 75% congruent pairings
  2. 50% incongruent and 50% congruent pairings
- Provides accuracy and reaction time for each condition and block

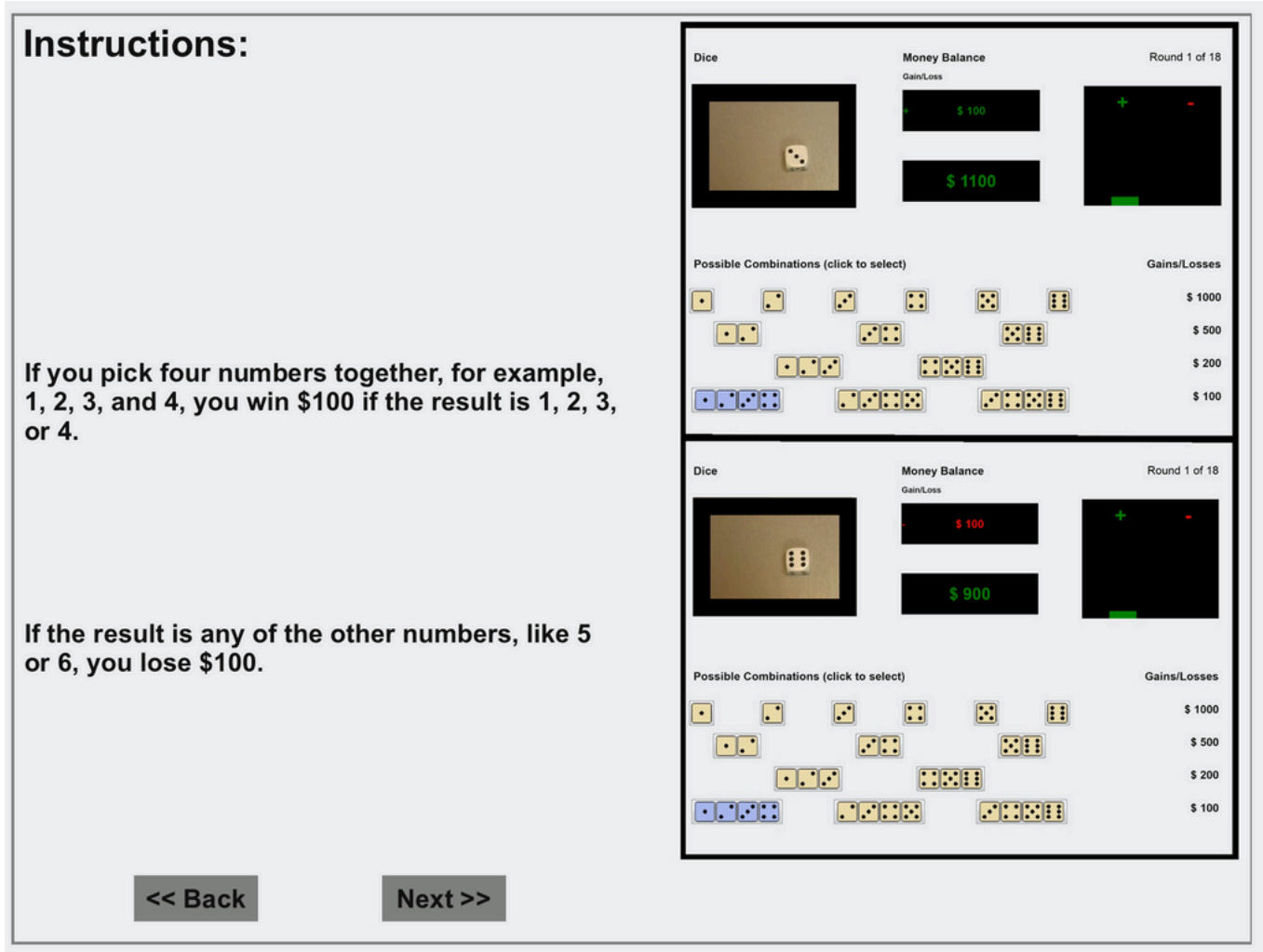


https://www.millisecond.com/download/library/stroop/abcdemotionalstroop/

Banich et al., 2019, Neuropsychologia.

Game of Dice Task

- ~6 minutes
- Adapted for ABCD by Millisecond using Inquisit platform
- Measure of inhibition and risky decision-making
- Provides number of safe vs. risky choices, wins, losses, and $ balance

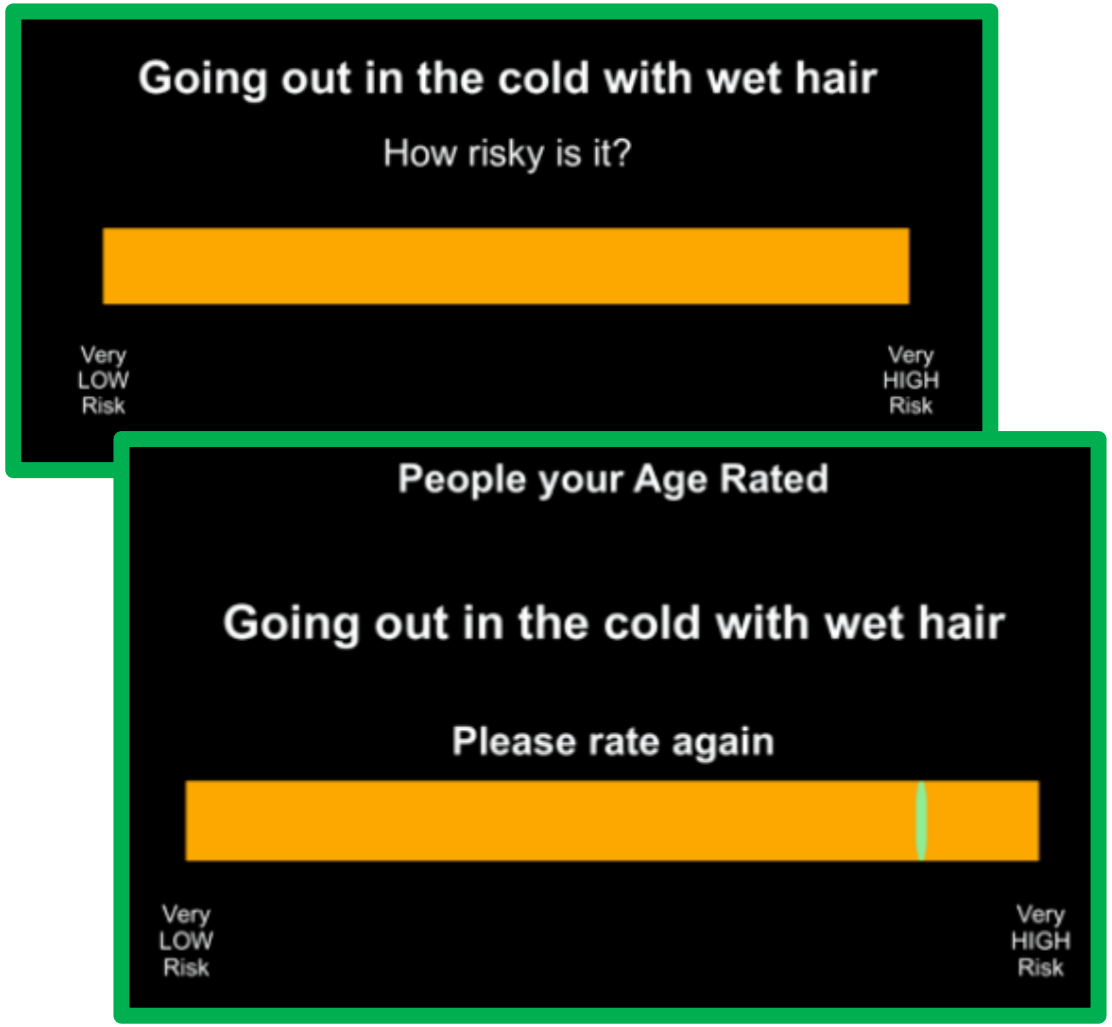


https://www.millisecond.com/download/library/gameofdicetask/

Brand et al., 2005, Neuropsychology.

Social Influence Task

- ~9 minutes
- Developed for ABCD by Millisecond using Inquisit platform
- Assesses social influence and risk taking
- Provides risk rating, and socially-influenced *change* in risk rating

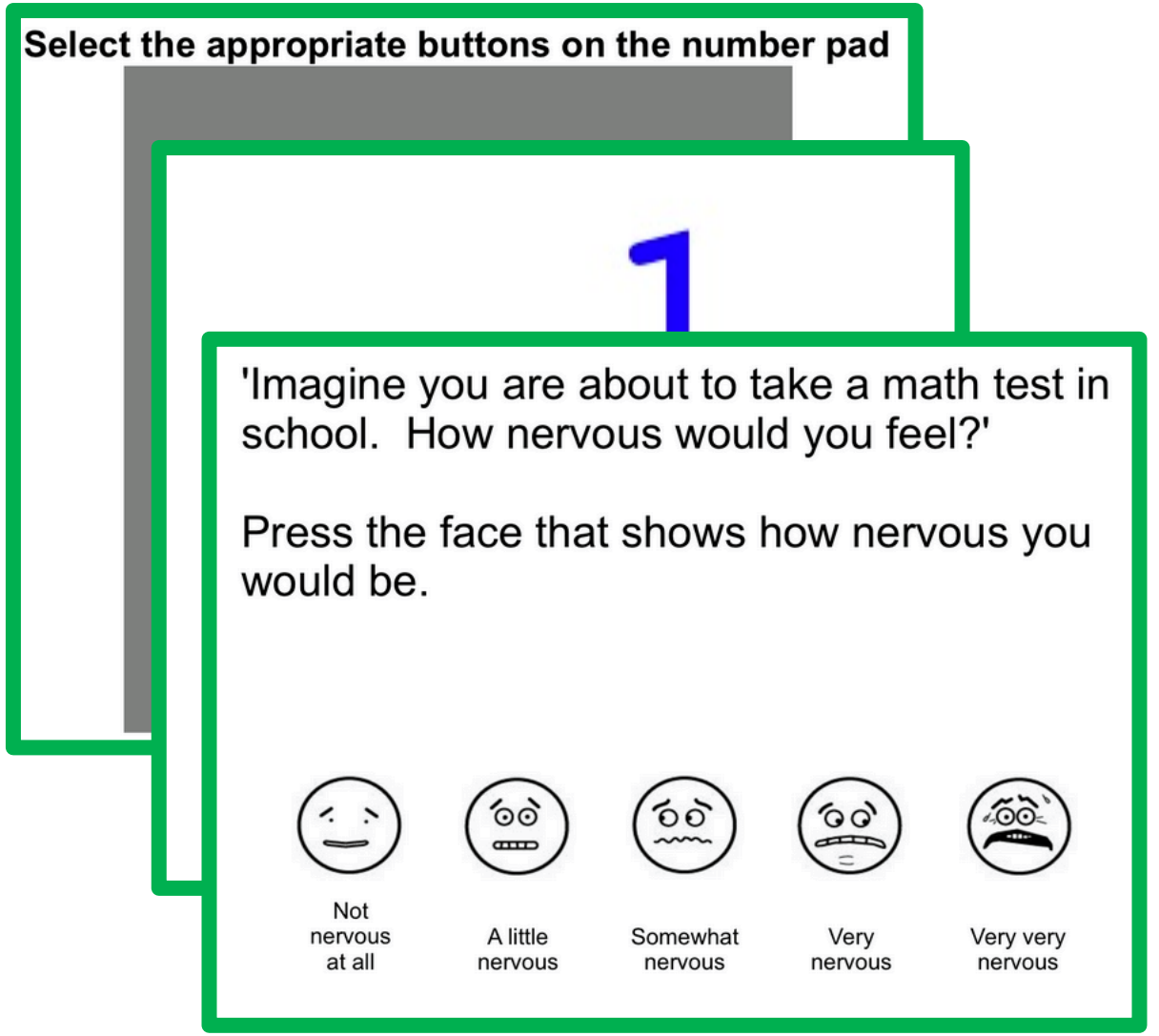


Based on Knoll, Leung, Foulkes, & Blakemore, 2017, J Adolescence

Stanford Mental Arithmetic Response Time Evaluation

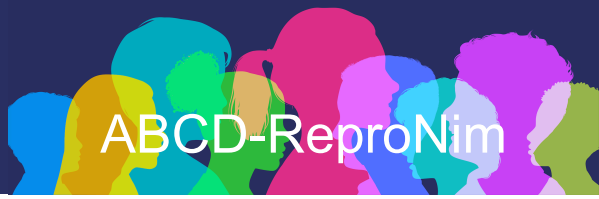
ABCD-ReproNim

- ~7 minutes
- Developed for ABCD by Millisecond using Inquisit platform
- Math Enumeration: speed and accuracy of perceiving dot arrays
- Math Fluency & Math Recall: how many simple addition and subtraction questions participant can complete in time
- Math anxiety item



Starkey & McCandliss , 2014, J Exp Child Psychology

Methodological Considerations



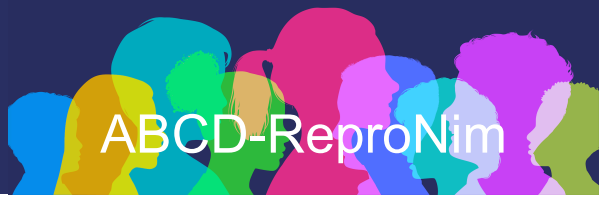
- **Training:**
  - Key to valid neurocognitive data
  - RA consistency facilitated by:
    - annual site visits with observations and feedback
    - weekly all-site RA meetings by Zoom
    - annual Train the Trainer meetings
    - detailed SOPs for each protocol element on Confluence accessible to all ABCD staff and investigators
  - ABCD Neurocognition Workgroup regularly evaluates data for irregularities

- **Vision** (Snellen) and handedness also assessed
  - You may want to exclude cases with low vision

Methodological Considerations

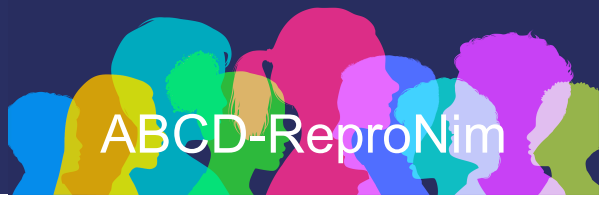
- **Practice effects**:
  - Challenge to any longitudinal study with repeated cognitive tasks
  - Compare those who missed tasks at prior time point versus those who had it
    - 1% of participants per time point (n=~117)
    - Compare those who took versus didn’t take a task on demographic and other variables
    - Estimate extent to which prior testing influences subsequent performance
  - Overlapping assessments of youngest (age ~9 at baseline, age 11 at two-year follow-up) with oldest subjects (age 10.9 at baseline), allowing for "once-vs-twice tested" estimation of practice effects in context of development

Methodological Considerations



- Tasks typically given annually in-person, by trained RA via iPad
- COVID-19 Pandemic:
  - ABCD quickly developed versions for remote administration
  - At-home versions given via smart phone (most common platform across participants)
  - March 2020 – ?
    - 3-year follows ups all remote
    - Includes the 3 usual tasks, given via smartphone remotely
  - July 2020 - ?
    - 2-year follow-ups remote OR with modified in-person protocol
    - Remote: includes all the usual tasks except:
      - No TB Pattern Comparison Processing Speed
      - No Snellen vision test
      - Youth or parent's smart phone is used instead of an iPad
      - Millisecond smart-phone Flanker task (rather than Toolbox's Flanker)
  - Modified in-person:
    - If youth has no access to smart phone or quiet setting, may be tested on-site in separate room from staff using ABCD iPads

Summary of ABCD Neurocognition Battery



- Designed to examine:
  - Typical development
  - Altered trajectories due to environmental or genetic factors
- Tasks cover:
  - General Ability/Intelligence
  - Learning/Memory
  - Executive functioning / Cognitive Control
  - Reward
- Methodological considerations:
  - Trained staff, regular checks for consistency
  - Remote administration in effect for pandemic and those who moved away
    - Mode of administration available in data releases
    - Should be considered for inclusion in models as may account for variability in performance

Acknowledgements

Workgroup Chairs:

Luciana, Monica (Co-Chair) – University of Minnesota

Bjork, Jim (Co-Chair) – Virginia Commonwealth University

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