

Observing Responsive Caregiving and Action Monitoring (ORCA)

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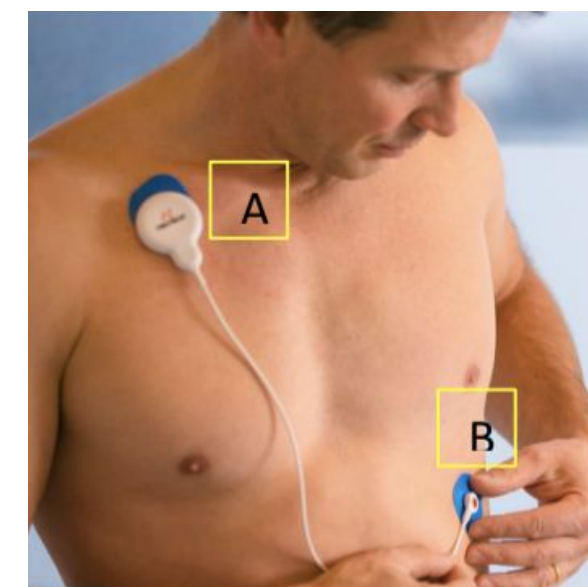


Introduction

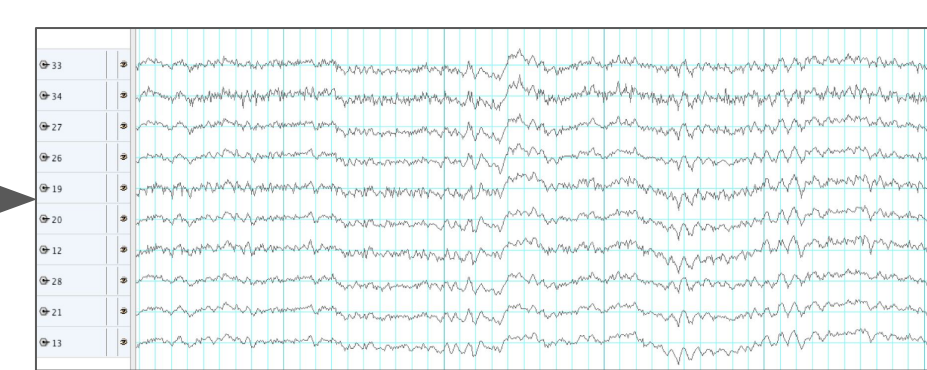
- Although parenting is naturally rewarding, chronic stressors such as food and housing insecurity impact a caregiver's interactions with their children
- Responsive caregiving is a caregiver's reaction to their child's social-communicative signals and a strong predictor of positive child outcomes
- We are seeking the mechanisms by which stress impacts parenting to maximize responsive caregiving and consequently support child development
- Our goal is to determine the presence of a neurobiological indicator of caregiver reward that can provide insight on how stress impacts responsive caregiving
- A neurobiological indicator of reward would provide a quantitative way to measure the effectiveness of parenting interventions
- We are recruiting 100 low-income mothers with children ages 3-6 to complete tasks while wearing an electroencephalogram (EEG) cap to measure the brain's electrical activity
- A task in which the mother watches her child complete a game measures observational reward positivity — the extent to which the mother responds positively when the computer rewards her child
- While other studies have examined neurobiological components of caregiving with functional magnetic resonance imaging, the EEG can be operated in a more natural social setting that mimics real-life caregiver-child interactions

Heart Rate Variability

- ECG electrodes will be applied for both caregiver and child
- A safe wireless ambulatory system records cardiac impedances of Heart Rate Variability (HRV)
- Caregiver and child will wear HRV during
 - 1) 3-minute baseline assessment to collect resting HRV
 - 2) Select number of tasks
- Baseline and task HRV will be compared



Electroencephalogram (EEG)



- Caregiver and child capped with stretchy 64-electrode cap soaked in mixture of water, KCl, and shampoo to conduct impulses from scalp to net
- Monitor electrical activity in the brain during tasks with millisecond precision

Isoprostanes

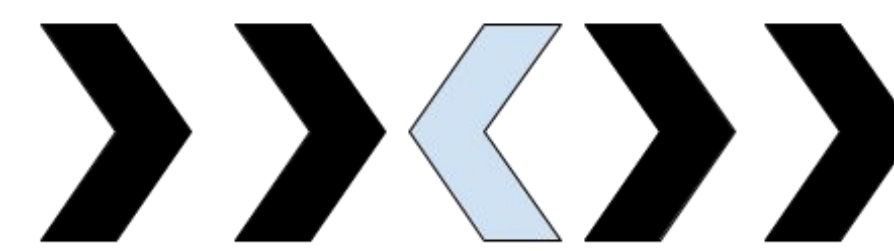
- Parent and child both complete urine analysis
- Measures F2-isoprostanes as biomarkers for oxidative stress and analyzed with gas chromatography-mass spectrometry
- Collect height, weight, and body mass index to control for body size

Zoo Game

- Inhibitory control task while child wears EEG net
- Children are tasked with helping zookeeper Annie catch escaped animals from a zoo
- Children are instructed to press a button when they see a picture of an animal (**Go Trials**)
- Children are told to not press a button when they see an orangutan (**No-go Trials**)

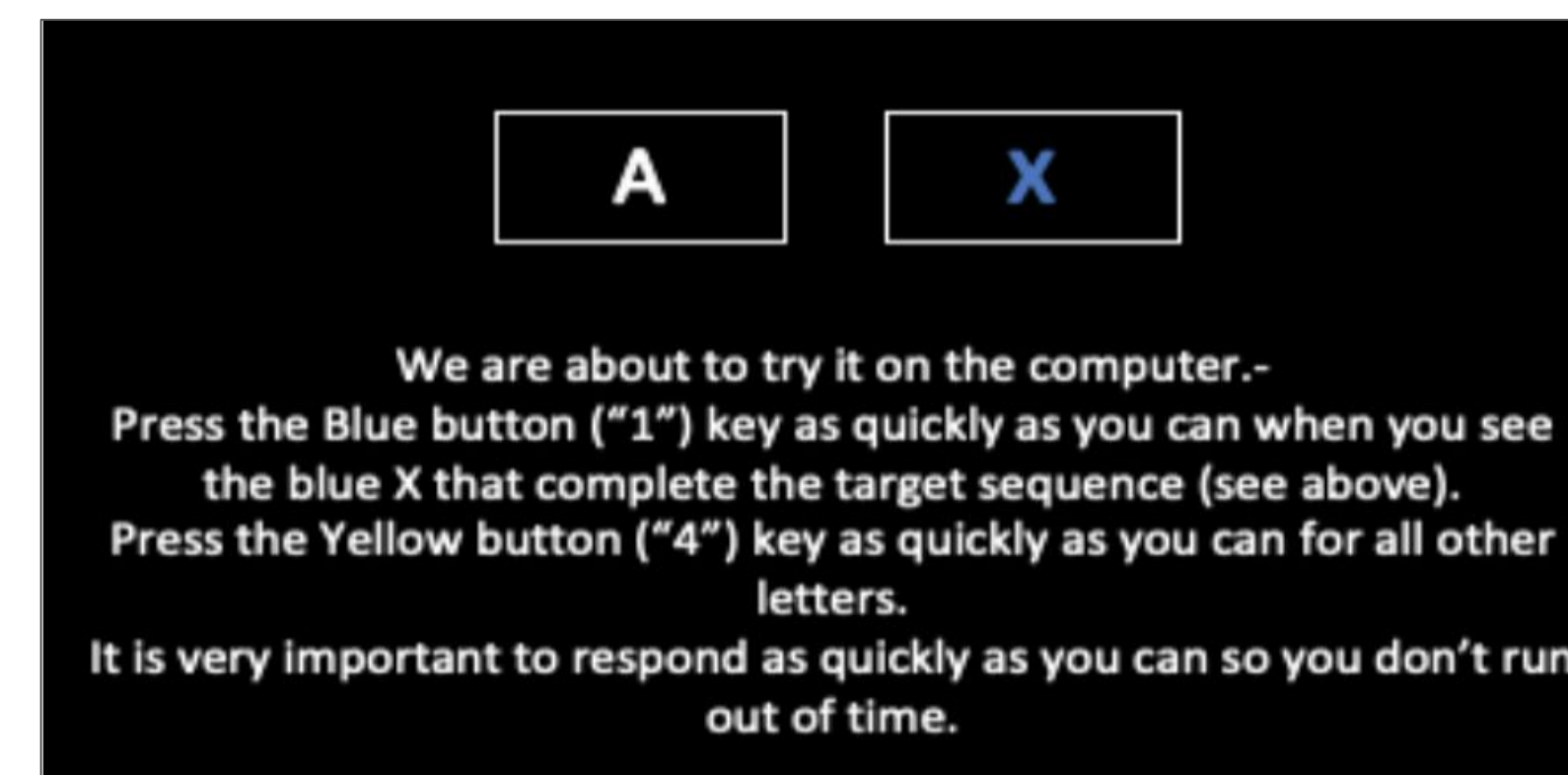
Flanker Task

- Response inhibition task for caregiver completed while wearing EEG
- Includes congruent (middle arrow facing same direction as other arrows) and incongruent (middle arrow facing opposite direction as other arrows) trials



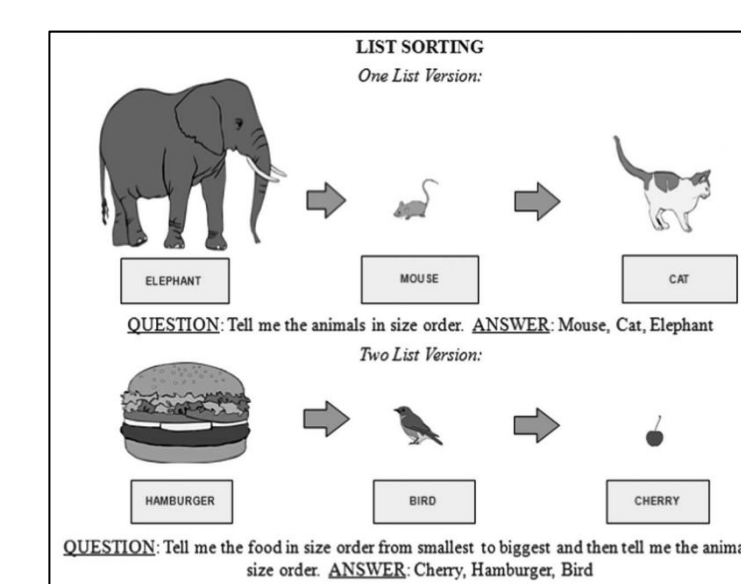
AX-CPT Task

- Cognitive control task aimed at testing context processing and goal maintenance
- Select one response for X preceded by A, another response for all other letter combinations
- Administered with the caregiver while wearing EEG



NIH-Toolbox Task

- List-sorting task examines caregiver working memory
- Present visual and oral sequences for participant recall

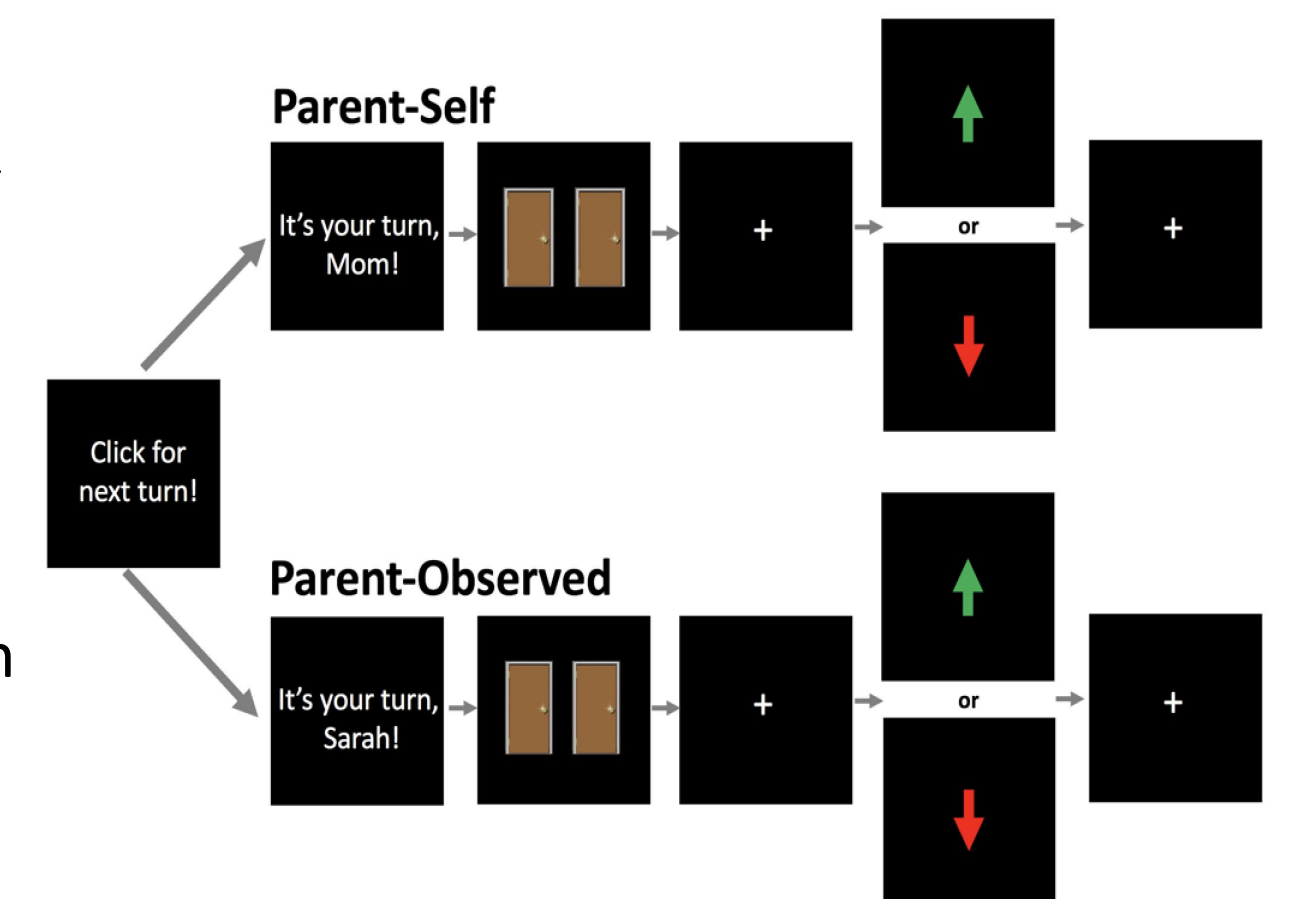


QUILS Task

- **Quick Interactive Language Screener (QUILS):** tablet-electronic based assessment of receptive language (3-6 years)
- The measure contains three major components:
 - **Vocabulary section:** children are given a number of choices and asked to select the correct picture that matches a given word
 - **Syntax measure:** assesses children's ability to understand different components of sentence structure
 - **Language Learning component:** measures children's ability to learn new words

Doors Task

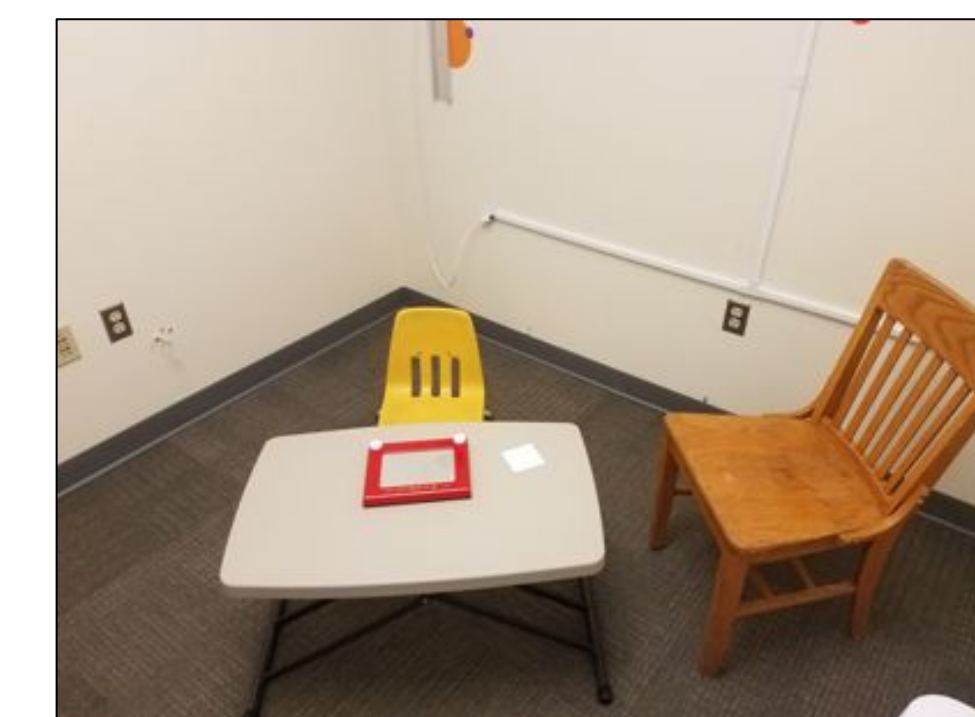
- 120 trial guessing task
- Participant selects door using response pad and receive feedback
- For each green thumbs up, child receives 1 treat and caregiver receives \$0.10
- For each red thumbs down, participants receive nothing
- Caregiver watches child's trials with EEG to measure observational reward positivity and feedback negativity



EF Touch Tasks

- Series of eight age-based tasks measuring executive function (selected based on age)
- Child selects answers on touch screen while experimenter reads instructions from adjacent monitor

Interaction Challenges



- Caregiver and child engage in tasks together including free play, puzzles, Etch-a-Sketch shapes, and Lego modeling
- Videotaped and coded with PICCOLO (Parenting Interactions with Children: Checklist of Observations Linked to Outcomes)
- Quantifies affection, responsiveness, encouragement, and teaching

Discussion

- We are currently running participants for this study and have completed 10 sessions thus far
- We are also recruiting more caregiver-child dyads via Craigslist Ads, and direct recruitment at local parks and community centers
- From this experience we have learned the importance of being flexible and adaptable in a session to fit the needs and capabilities of the participants involved
- We hope to find if caregiver reward could be a potential neurobiological indicator of responsive caregiving
- We also hope to understand more about how stress and adversity affects responsive caregiving

Acknowledgements

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Feedback-Related Negativity as a Neural Indicator of Executive Function in Preschoolers

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Dr. Tyson Barker, Dr. Philip Fisher, Leticia Hayes



Introduction

- Executive function (EF): cognitive skill that support early learning and development
- Prefrontal cortex: a primary brain region underlying executive function
- Prefrontal cortex develops during early childhood
- A neural component supporting executive function, feedback-related negativity (FRN), is measurable using electroencephalography
- Electroencephalography (EEG): a device that measures the brain's electrical activity
- FRN is observed following positive and negative feedback and is generated by the prefrontal cortex
- Same brain region underlies FRN and executive function
- We predict that child FRN will be positively related to a behavioral measure of executive function
- FRN may serve as a novel indicator of executive function**

Literature Search

On Feedback-Related Negativity Studies in Childhood

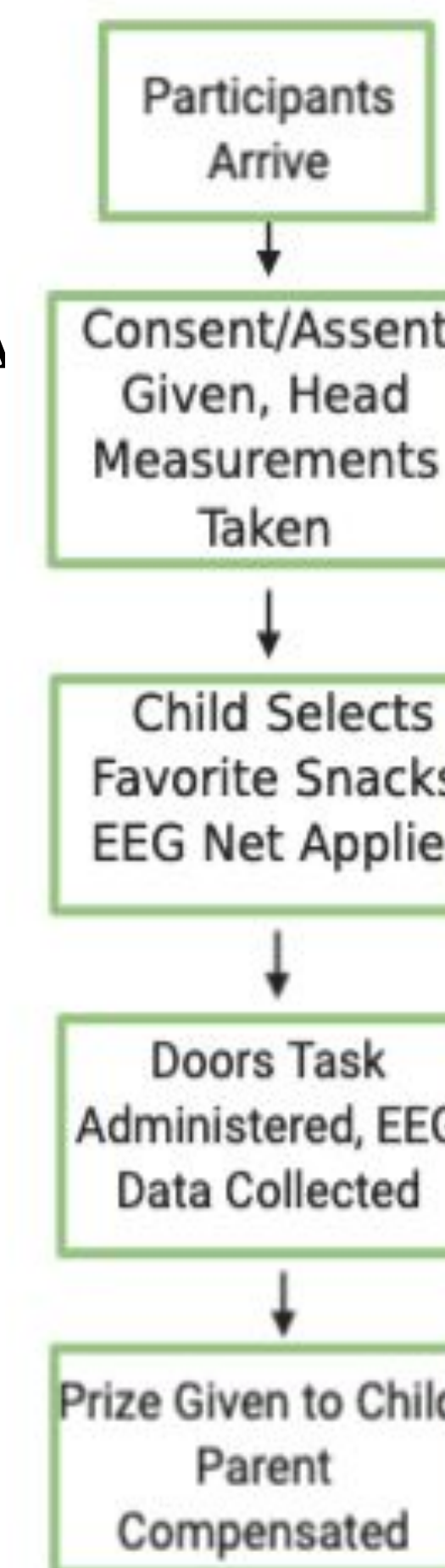
Authors, Year	Age	Methods Summary	Key Findings
Mai et. al., 2011	4-5	Rank-order prizes, gambling task	FRN no difference between negative and positive feedback
Eppinger, Mock, and Kray, 2009	12-18, 18-22	Probability-based learning task	FRN is greater for children
Crowley et. al., 2013	10-12, 13-14, 15-17	Gambling task; select balloons for monetary reward	FRN is greater in younger participants
Hämmerer et. al., 2011	9-11, 13-14, 20-30, 65-75	Varied probabilities for 2 options resulting in reward/loss	FRN decreases with age
Meyer et. al., 2014	30 mo.	Feedback supplemented matching game	FRN appears in toddlers

Key Takeaways

- Limited research has been done on feedback processing in early childhood
- Research suggests that feedback related negativity **may appear as early as 2.5 years old**

Methods

- 25-30 Participants
- Ages 4-6
- Participants will be asked back from ORCA Part I to compare data with previous sessions
- Sessions are approximately 1 hour long
- Parents are compensated with money, and the child receives a bag of toys



We will examine the relationship between **EXECUTIVE FUNCTION** and **FEEDBACK RELATED NEGATIVITY** in preschool-aged children

Executive Function

- Cognitive skills that help regulate child behaviour
- 3 aspects of executive function examined in our study: attention shifting, inhibitory control, and working memory
 - Working Memory*: recall and use information short-term
 - Inhibitory Control*: ability to control impulses
 - Attention Shifting*: ability to move between tasks

Feedback Related Negativity

- Observed following both positive and negative feedback during Doors Task
- Generated by the prefrontal cortex, more specifically the dorsal anterior cingulate cortex
- Observable through an event-related potential (ERP) in response to negative feedback (monetary loss, not getting a snack, etc.)

Overview of Tasks

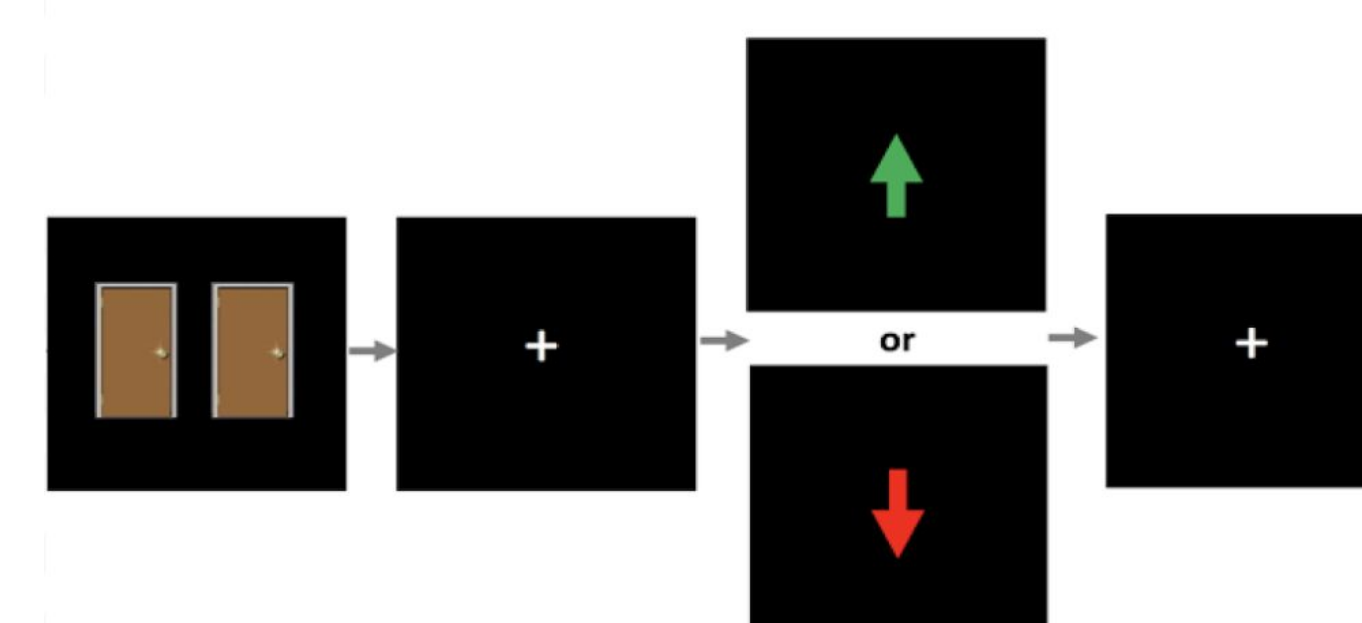
Executive Function

EF Touch Tasks

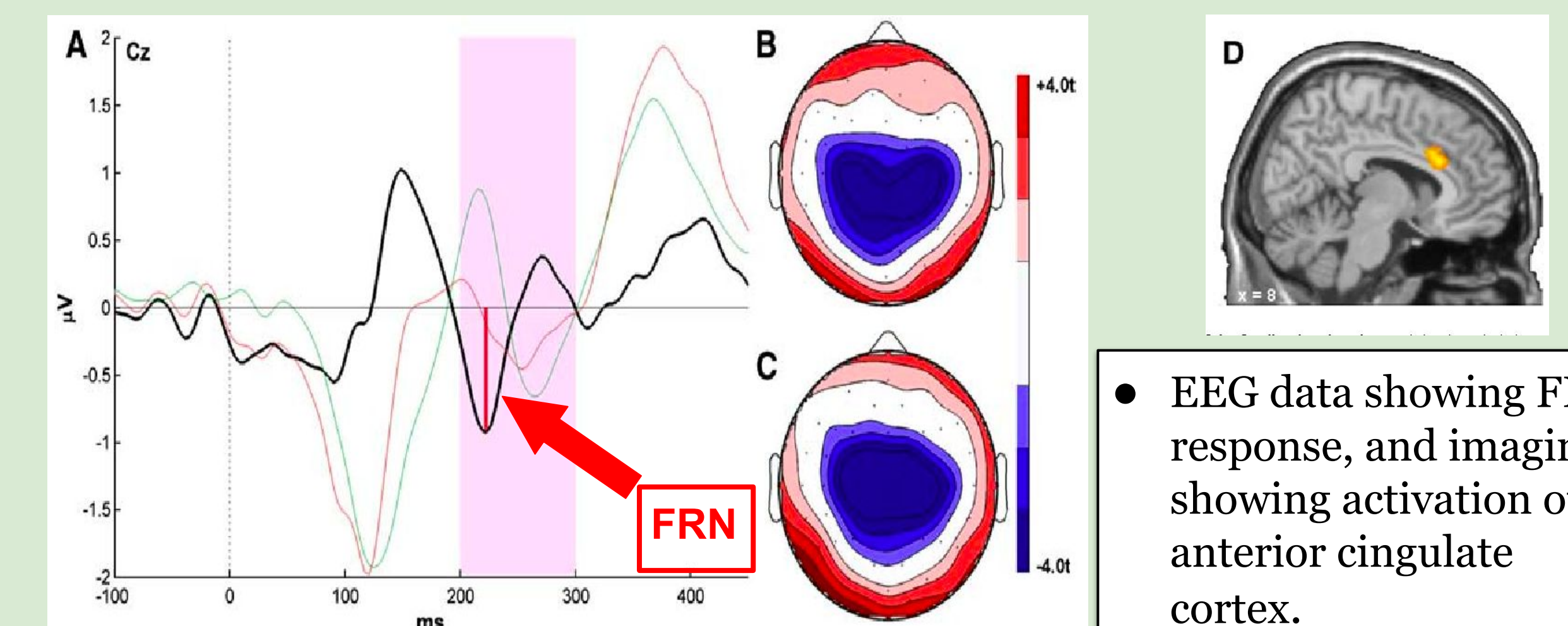
- Series of eight age-appropriate task **measuring executive function**
- Child selects answers on touch screen while experimenter reads instructions from adjacent monitor
- Collected during ORCA Part 1 (previous study)

Feedback Related Negativity

Doors Task



- Child wearing EEG, this task will **measure Feedback-related Negativity**
- Participant selects door using response pad and receive feedback
- For each green thumbs up, child receives 1 treat
- For each red thumbs down, participants receive nothing



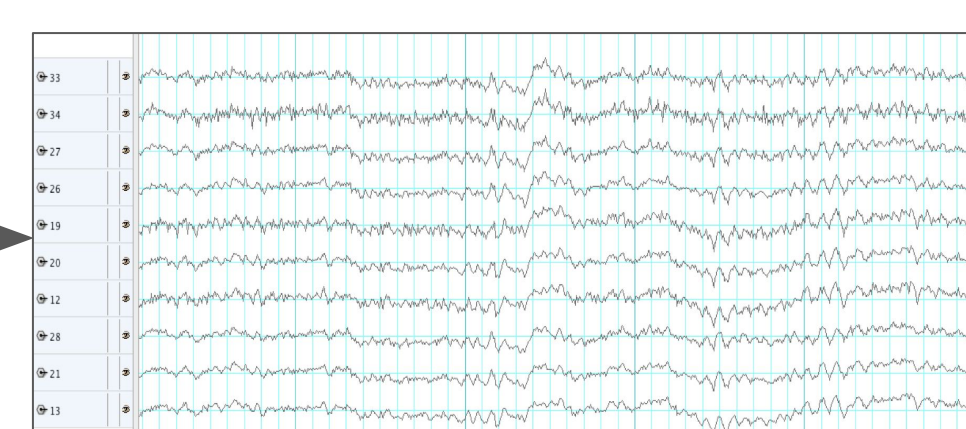
Haase, T. U., Iannaccone, R., Stampfl, P., Drechsler, R., Brandeis, D., Walz, S., & Brem, S. (2014). The feedback-related negativity (FRN) revisited: new insights into the localization, meaning and network organization. *NeuroImage*, 84, 159-168.

- EEG data showing FRN response, and imaging showing activation of anterior cingulate cortex.

Discussion

- We expect to see that EEG measures of FRN will show a pattern with EF Touch Task scores
- The Doors Task provides the participants with immediate positive reward in the form of snacks. This is predicted to hold children's attention better than tasks from previous research.
- Learning about the relationship between EF and FRN in childhood can guide how educators and teachers foster cognitive development.
- Due to COVID-19, sessions are not currently being held, but the study will proceed as soon as labs are open again.
- We are learning to use this time to prepare for efficient data collection

Electroencephalogram (EEG)



- Child capped with stretchy 64-electrode cap soaked in mixture of water, KCl, and shampoo to conduct impulses from scalp to net
- Monitor electrical activity in the brain during tasks with millisecond precision

Acknowledgements

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Leticia Hayes, Tyson Barker, Kellyn Blaisdell, Anna Wright

- Introduction/Background (nishi)*
- Executive Function (nishi)
- EEG (Dak)
- FRN (Dak)
- Methods (Dak)*
- Doors Task (done)*
- Literature Review*
- Expected Results (Katia)
- Discussion/Overview/Moving forward/COVID (Katia)*
- Acknowledgements (everyone)
- Literature Review Link:

<https://docs.google.com/spreadsheets/d/1EoZ8k>