Developmental Differences in Reward Processing: Investigating the Reward Positivity ERP in an Adapted Doors Task

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Introduction

- Reward processing shapes behavior and socioemotional development, yet its early childhood trajectory is poorly understood.[1, 2]
- The Reward Positivity (RewP) can be observed with electroencephalography (EEG) and reflects differentiation between the neural responses to reward vs loss, seen as a positive peak in the reward condition between 250 – 550 ms.[3]
- The RewP is reliably elicited by the Doors task[4], a simple binary choice paradigm validated in adults and children as young as 4 years.[5,6] The RewP has not yet been reliably observed in 3-year-olds.
- It is critical to understand early development of reward processing which could help improve early intervention strategies that rely on rewards to motivate children.

Objectives

1. Determine whether our child-friendly adaptation of the Doors task elicits a RewP
2. Identify age-related changes in RewP amplitude and latency

Methods

Participants: 64 children ages 3-5 years
Final sample (n=48; Table 1) after exclusion for developmental concerns (n=10) and EEG quality (n=6)

Paradigm: Adapted Doors Task (Figure 1)

Analysis:
- Two Linear Regressions
  - RewP Amplitude ~ Age (group)
  - RewP Latency ~ Age (group)

Table 1. Demographics

	n	%
N	48	43.8 (Male)
Age (months)		
Mean (SD)	52.7 (10.8)	
Range	36–71	
Race		
White	39	81.3
Black	6	12.5
Multi-race	3	6.3
Hispanic (Y/N)		
Yes	10	20.8
No	38	79.2

ERP Acquisition & Processing:

- EGI Magstim Geodesic Hydrocel 128 channel net
- HAPPE Pipeline[7]:
  - Down-sample to 500Hz
  - Line Noise Removal (60Hz; Cleanline)
  - EEGLAB's Fir Filter (High: 0.1Hz; Low: 35Hz)
  - Wavelet Thresholding (Hard)
  - Bad Channel Detection
  - Segmentation (-200-1000ms)
  - Baseline correction (-200-0ms)
  - Segment Rejection (Amplitude +/- 200 µV)
- Re-reference to mastoids (E100, E57)
- Region of Interest: Frontal (E4, E11, E16, E19, E10, E18, E12, E5, E6)
- Exclusion Criteria:
  - Fail >5 ROI electrodes (n=0)
  - Fail mastoid electrodes (n=5)
  - Percent Variance Retained Post Waveletting < 0.10 (n=1)

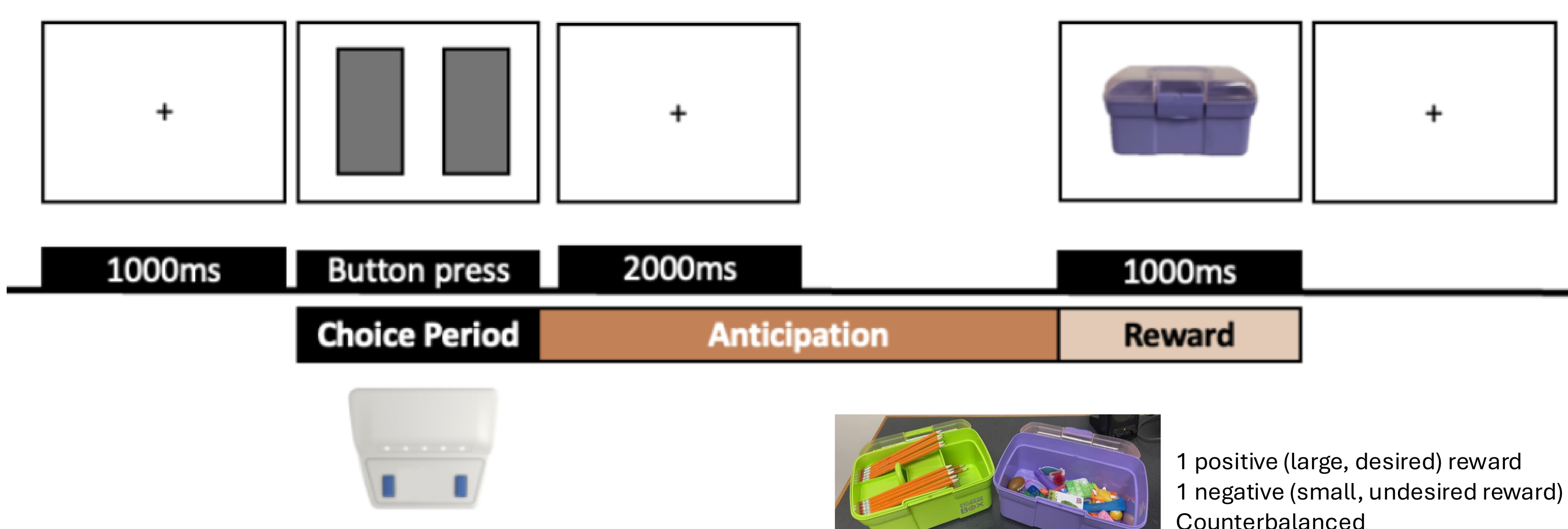
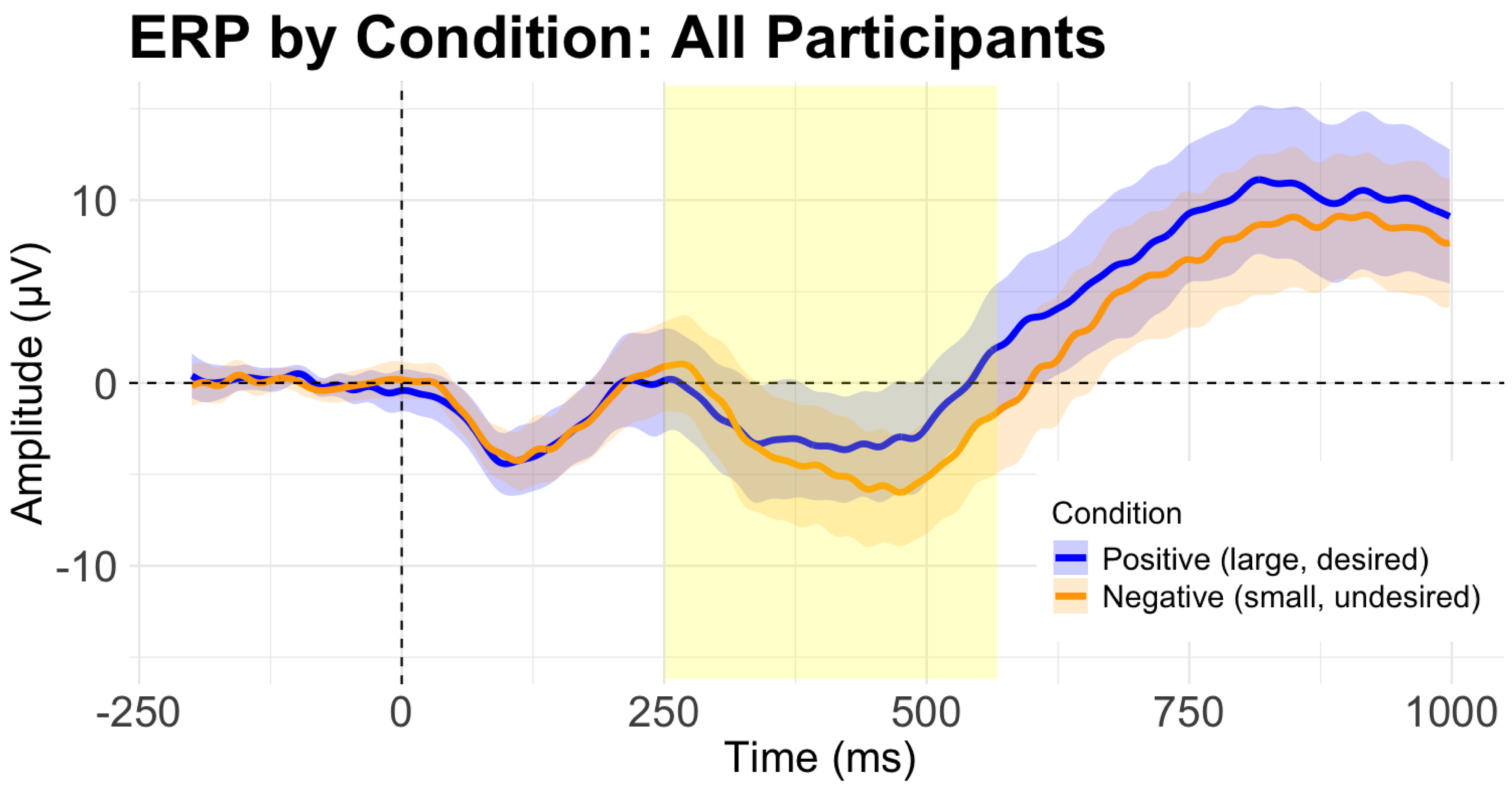
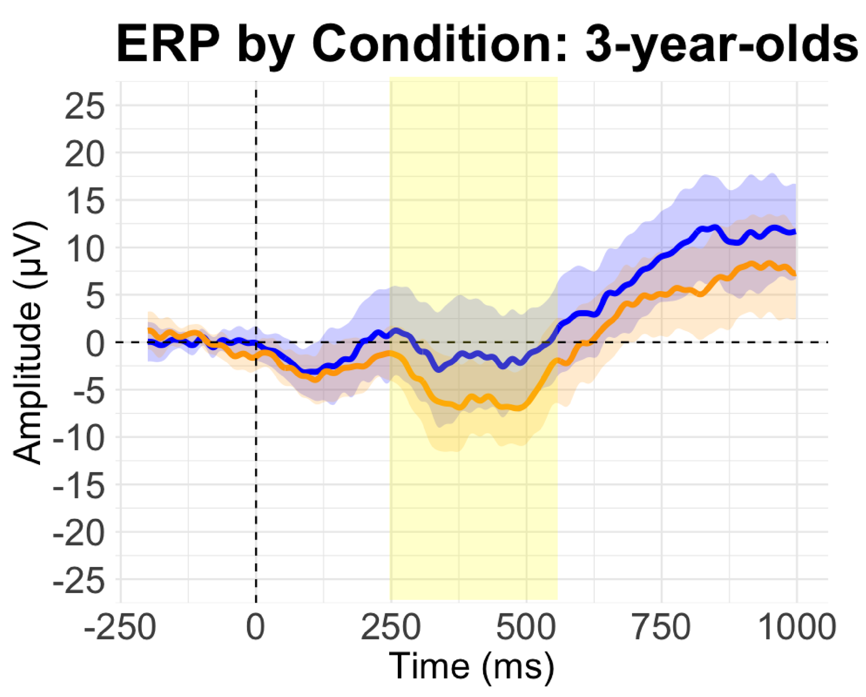
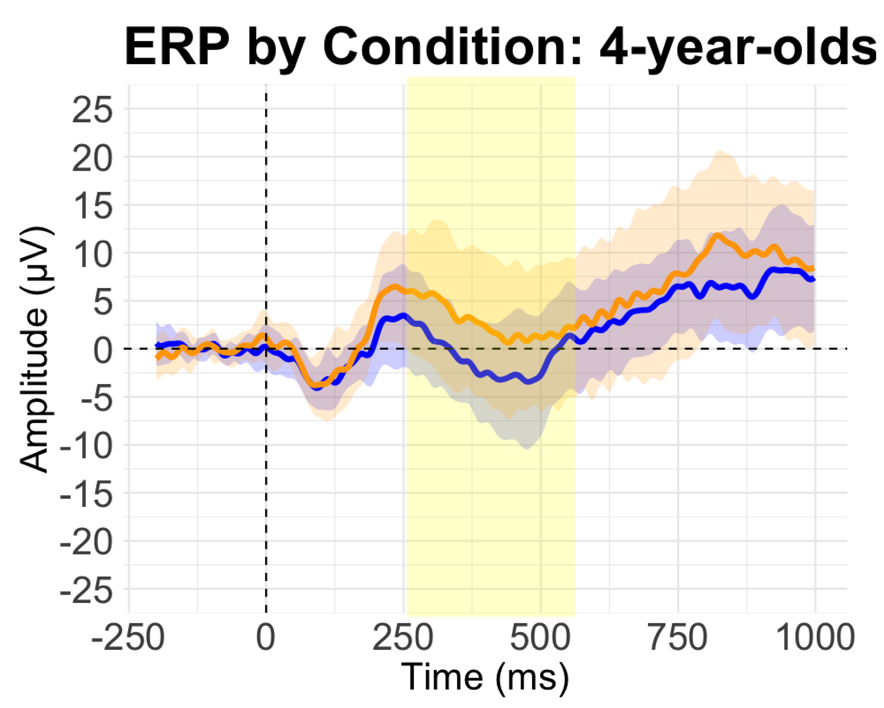


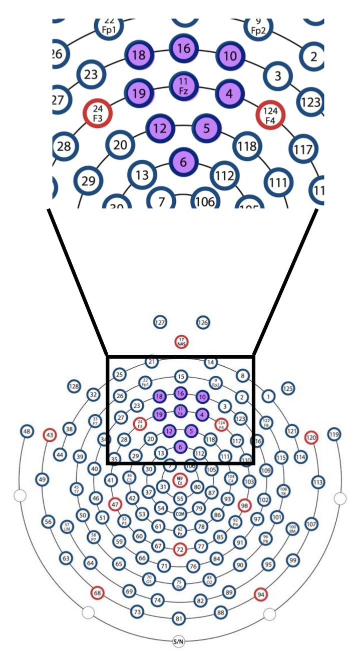
Figure 1. Adapted Doors Task experimental paradigm

Results









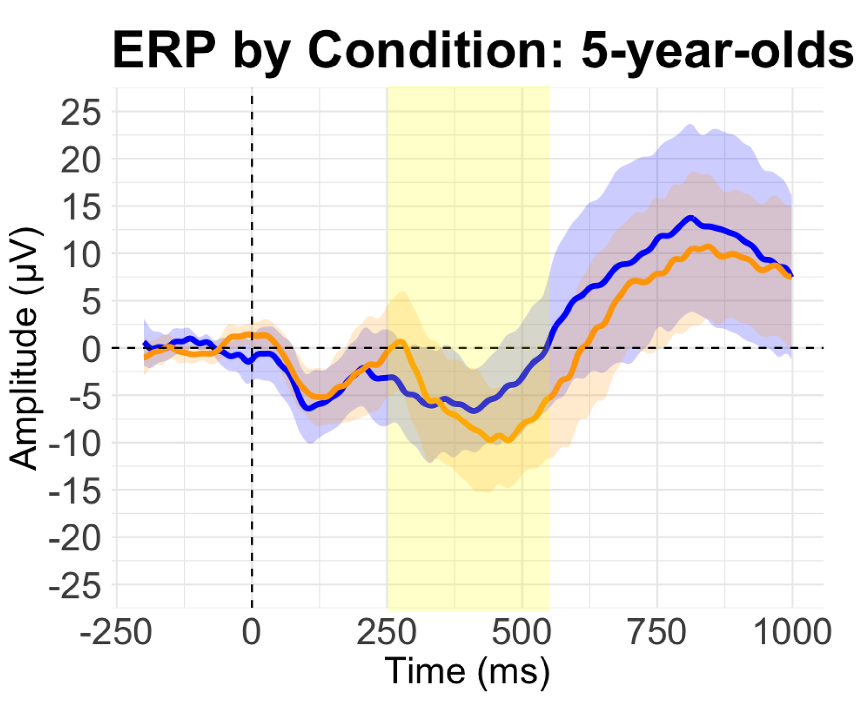


Figure 2. ERP by condition, split by age group. Time period of interest shaded in yellow.

Table 2. RewP Amplitude by Age Group

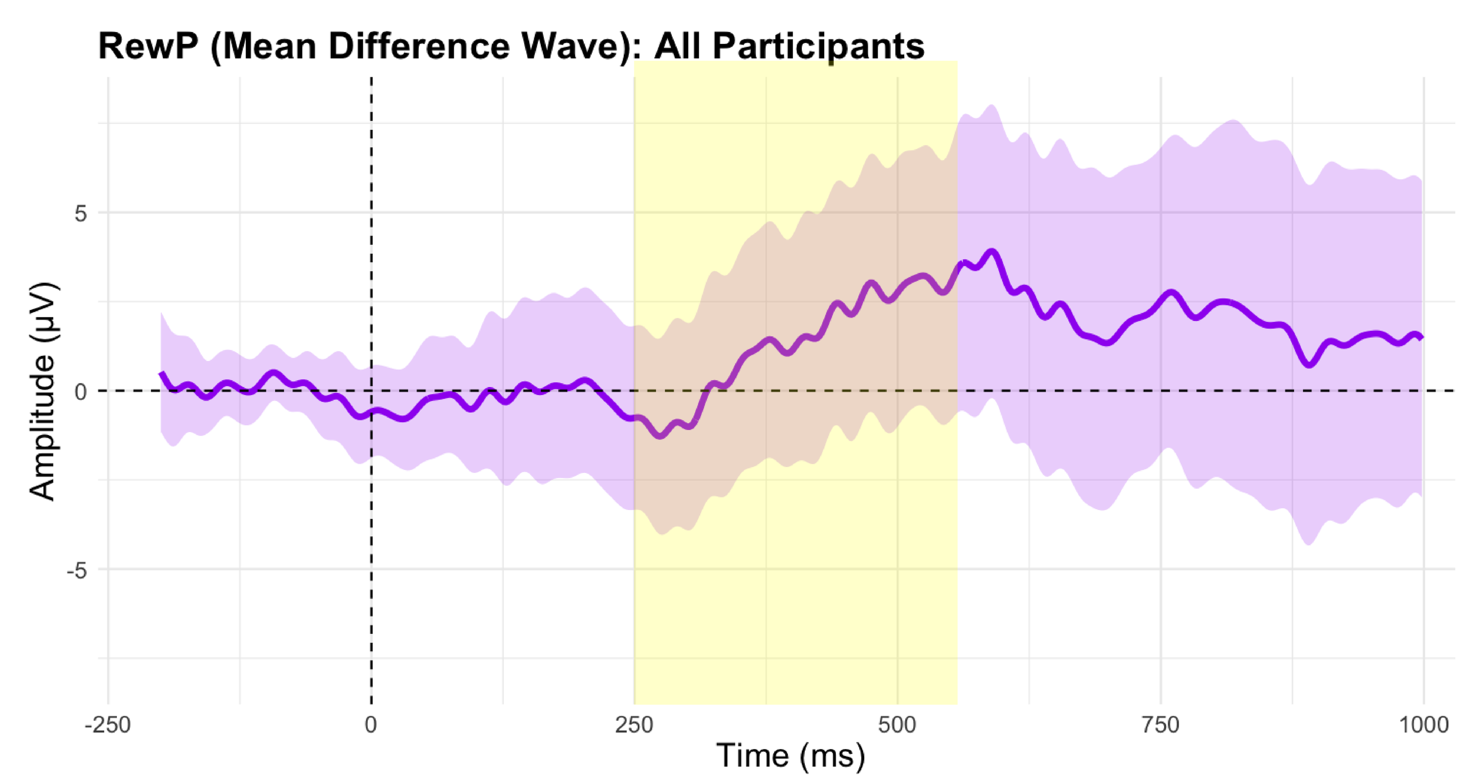
Age Group	Estimate	SE	t	p
Age 5* (n=17)	10.91	2.78	3.93	< .001
Age 4 (n=12)	-9.01	4.32	-2.09	.04
Age 3 (n=19)	1.58	3.82	0.41	.68

Note. R^2 = .13, Adjusted R^2 = .09, F(2, 45) = 3.42, p = .04. *Reference group

Table 3. RewP Latency by Age Group

Age Group	Estimate	SE	t	p
Age 5*	438.94	20.36	21.56	< .001
Age 4	-32.77	31.65	-1.04	.31
Age 3	-35.68	28.03	-1.27	.21

Note. R^2 = .04, Adjusted R^2 = -.002, F(2, 45) = 0.93, p = .4. *Reference group



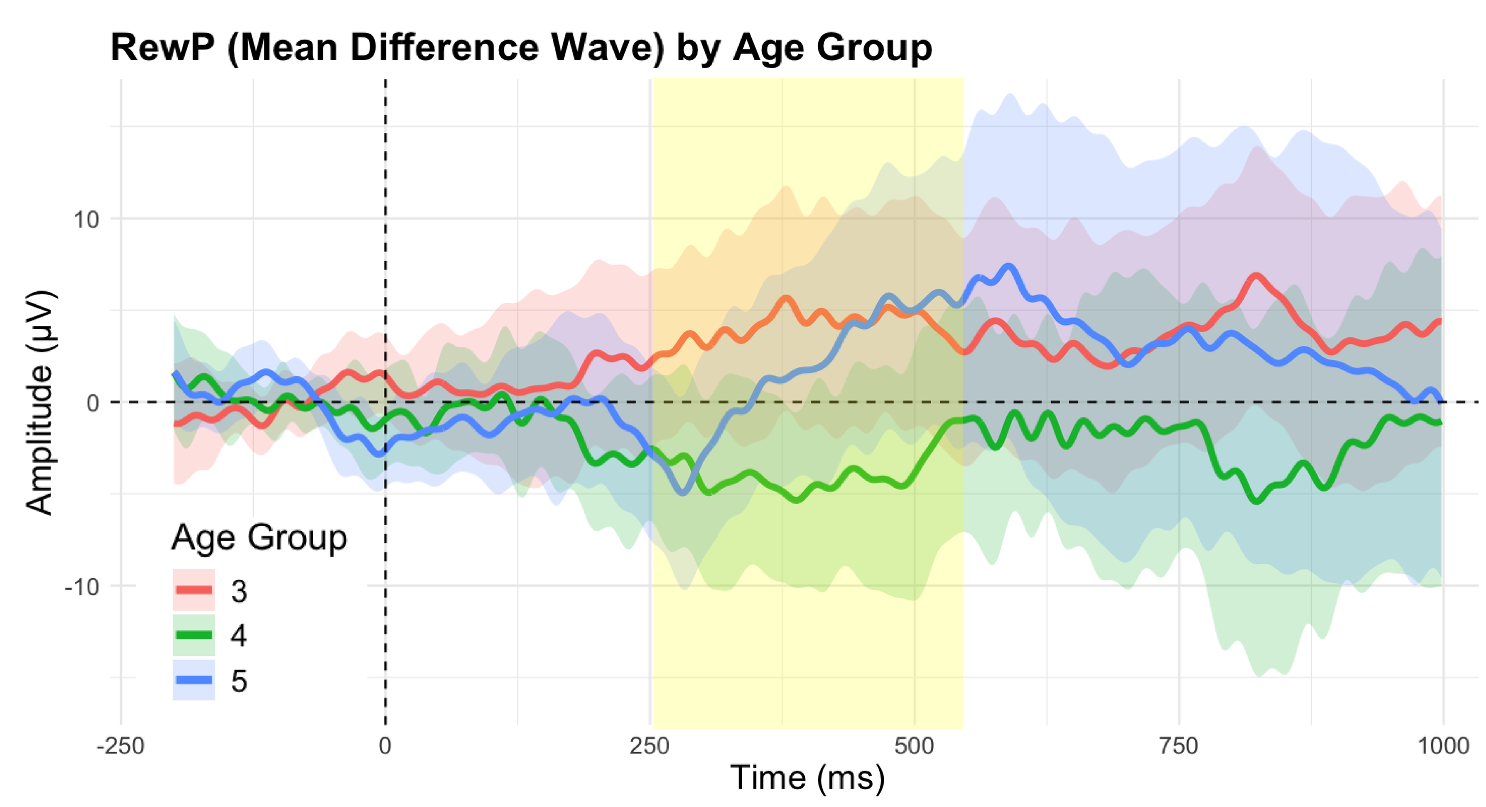


Figure 3. RewP (difference wave) for all participants (top_ and RewP (difference wave) by age group (bottom). Time period of interest shaded in yellow.

Conclusion

- Visual inspection of waveforms shows separation between conditions (desired vs. undesired reward). RewP emerging and may become clearer as additional participants added.
- Age did not significantly predict difference wave peak amplitude or latency.
- Surprising condition reversal observed for age 4

Future Directions

- Age-related differences may be subtle or require larger samples to detect
- Analyzing the RewP as a residual, as difference waves show poorer psychometric properties[8]
- Assess influence of gender and developmental level on RewP amplitude and latency

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