

The Reward Positivity in Very Young Children: A Doors Task Investigation

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Introduction

- Reward processing is the way in which individuals interact with an appetitive stimulus. 3 core components: anticipation, effort, and response (Clements 2023)
- Reward response component quantified by the Reward Positivity (RewP) Event Related Potential (ERP) measured with electroencephalography (EEG)
- RewP is frontocentral, positive, elicited 250-550 ms after reward received (Figure 3)
- Differences appear to exist between adult male and female reward processing. Adult females demonstrate increased RewP amplitude (Distefano 2018)
- Relatively little research examining RewP in very young children, as many tasks traditionally used to elicit RewP are too complex
- We lack information about reward processing's development and how that development may be modulated by gender or cognitive processing ability
- Reward processing differences linked to developmental disorders, mental illnesses (Belden 2016), understanding trajectory could provide insight and intervention

Objectives

- Utilize an adapted version of the Doors Task to elicit RewP in children
- Determine if female and male children exhibit differences in RewP latency or amplitude; examine how those differences develop over time
- Examine how chronological and developmental age impact Doors RewP in children

Methods

- Participants: 71 children aged 3-5 ($M=4.41$, $SD=0.92$) recruited from South Bend area. 36 male children, 35 female (Table 1)

Doors Task

- A validated reward processing task in which RewP is elicited through rewarding or nonrewarding feedback (Carlson 2011)
- Participants are presented with an appetitive and neutral stimulus and must win the appetitive one through a binary guessing choice
- Original task adapted in this study for young population, extending existing modifications (Belden 2016)
- Paradigm: Figure 1, Materials: Figure 2. 60 trials (+ 8 teaching trials)
- Cognitive ability measured by Differential Ability Scales, II (DAS-II): Global Conceptual Ability (GCA) score

EEG

- 128-electrode Hydrocel net applied prior to task
- EEG Region of Interest (ROI) Electrodes: E4, 5, 6, 10, 11, 12, 16, 18, 19
- Data processed with HAPPE pipeline: noise removal (60 Hz), baseline correction, segment rejection (Amplitude ± 200 μV), artifact detection via waveletting
- Exclusion criteria: Failing >2 ROI electrodes or a mastoid (E100, E57) electrode

Figure 1: Digital Doors Task paradigm display.

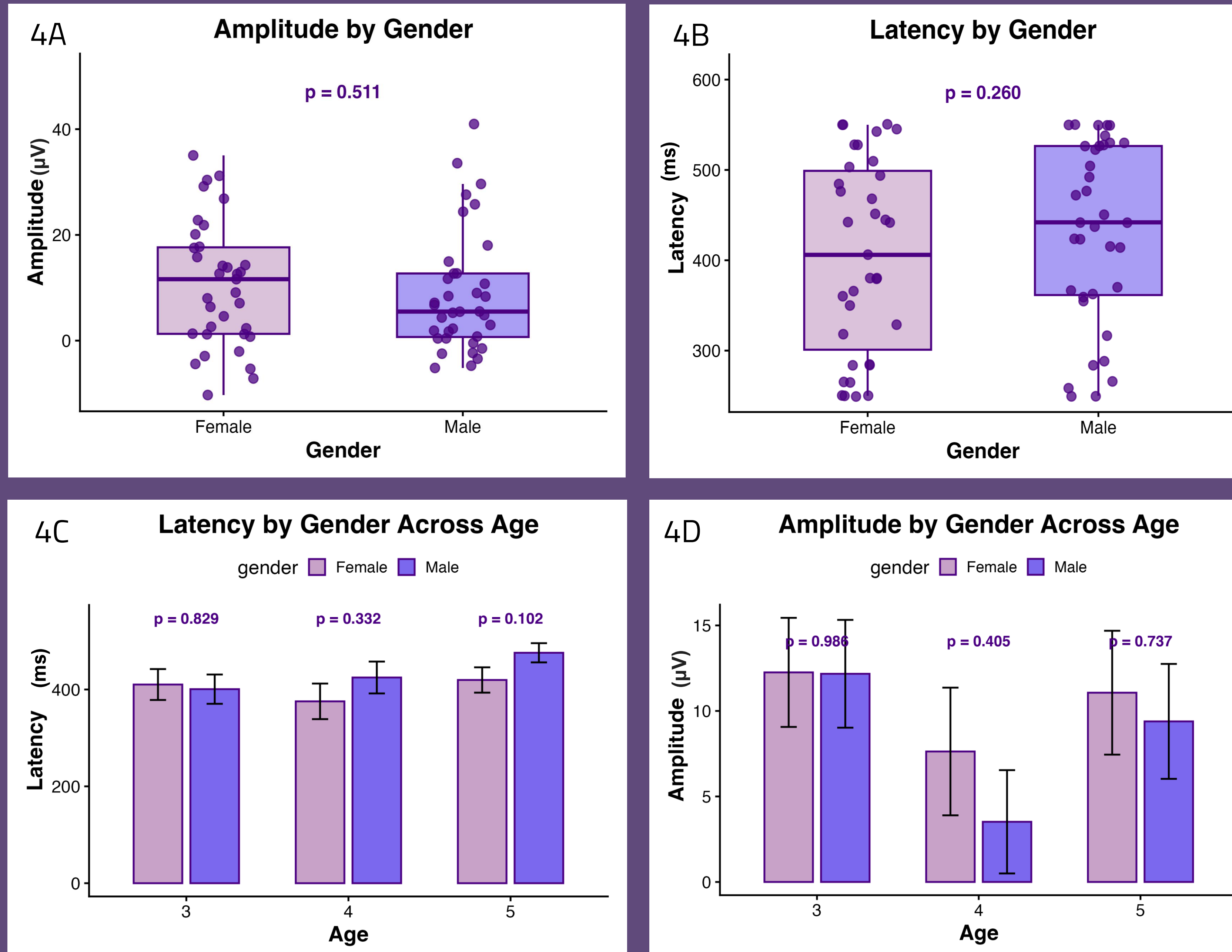
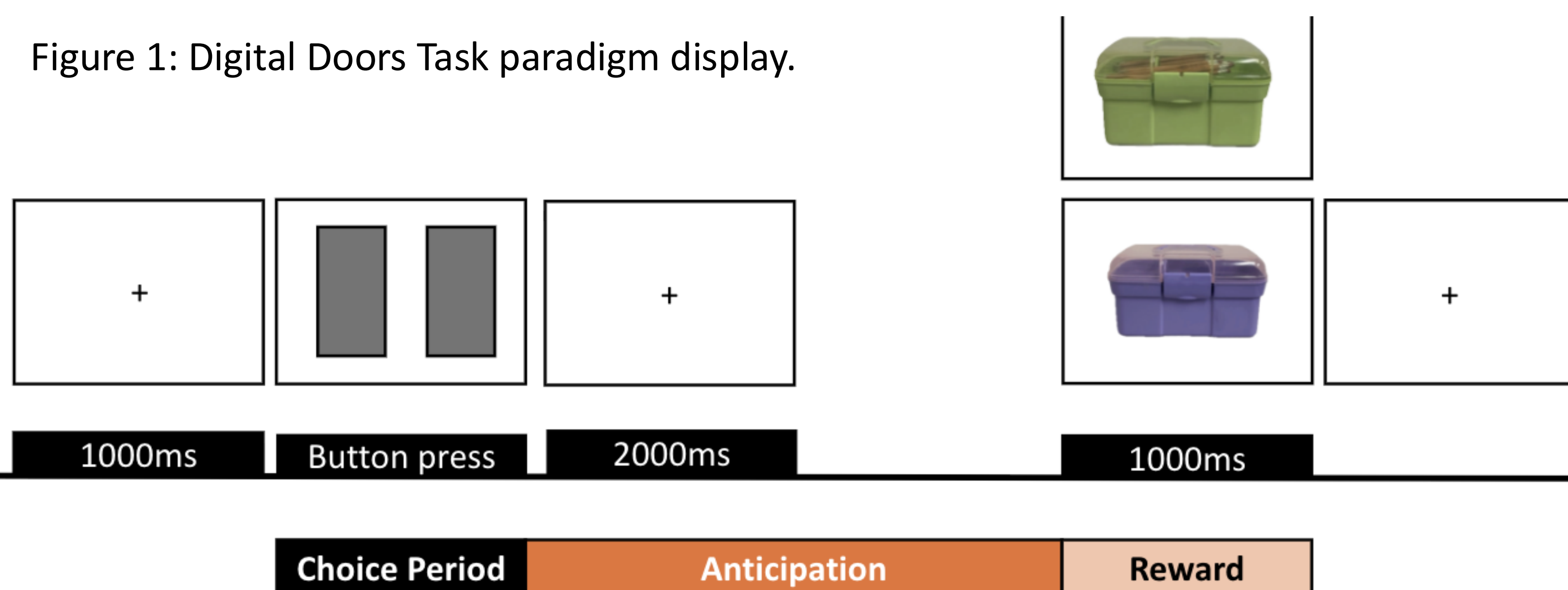


Figure 4: Gender had no effect on RewP amplitude or latency in any age bracket.

Demographic Characteristics

Characteristic	Value
Age	
Mean age, years	4.41 $\pm$ 0.92
Gender	
Female	35
Male	36
Age Bracket	
3 years	28
4 years	19
5 years	23
6 years	1
Race	
Black	6
Multiracial	8
White	57
Ethnicity	
Hispanic or Latino	12
Not Hispanic or Latino	59

Figure 2: Adapted Doors Task components

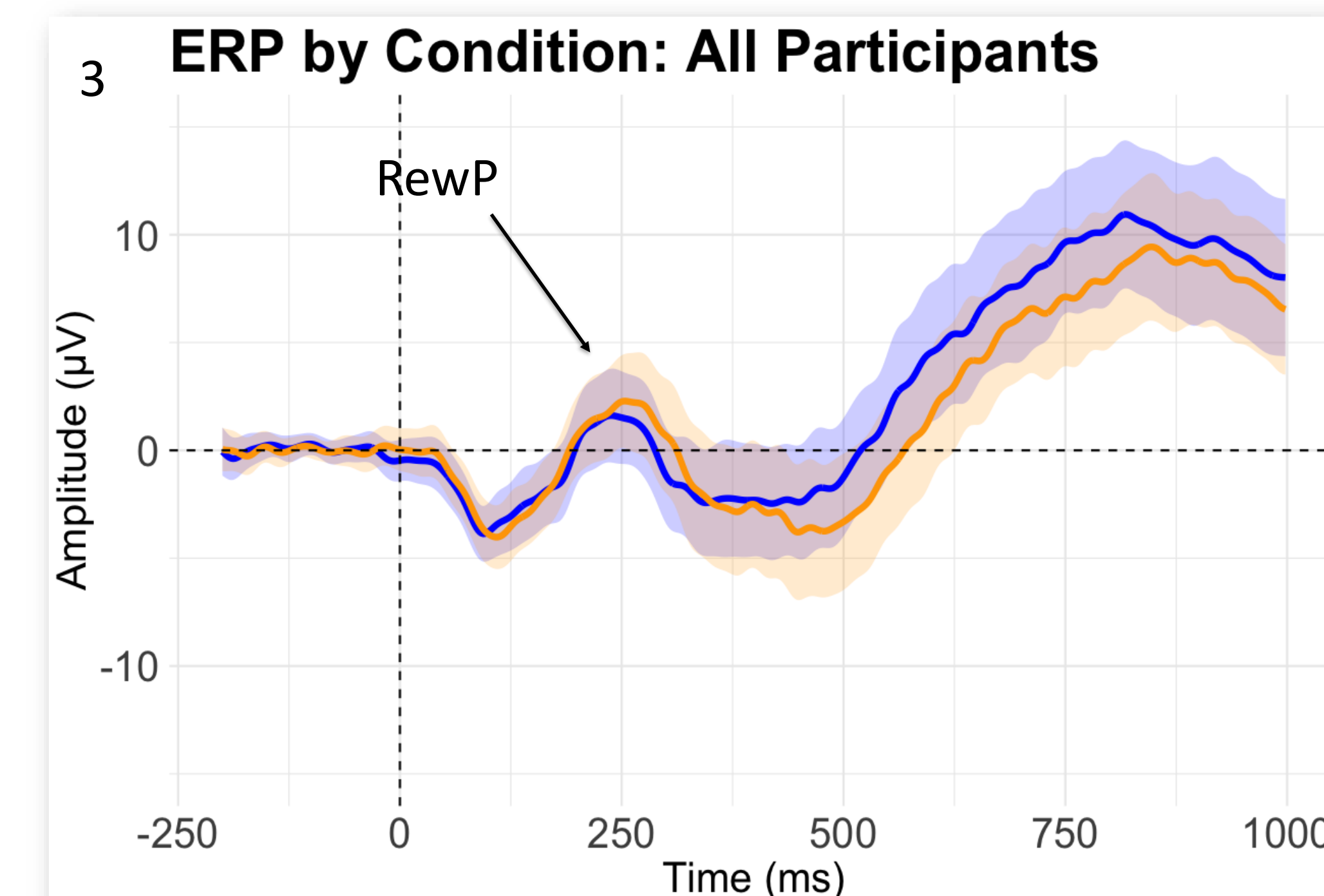


Table 2. Pearson Correlations

Correlation	n	r	p
Amplitude and Age	71	0.02	0.853
Amplitude and GCA	71	-0.11	0.370
Latency and Age	71	0.22	0.059
Latency and GCA	71	0.20	0.092

Note. $p < 0.05$.

No significant correlations between chronological or developmental age and amplitude or latency.



Discussion

- Gender had no effect on RewP amplitude (4A) or latency (4B) in any early age bracket (4C, 4D)
- Neither RewP amplitude nor latency appear to be associated with gender in early age groups
- Indicates that reward processing differences between genders likely arise after this timeframe
- Suggests sex may not need to be considered as a covariate in future Doors analyses
- Global Conceptual Ability not correlated with amplitude or latency (Table 2); points towards separate reward processing pathway
- No significant relationship found between age and amplitude or latency (Table 2)
- Unexpected given pattern of amplitude increasing and latency decreasing with age (Hennefield 2021), could be due to inconsistent RewP in 3-year-olds

Limitations

- Difficult to ensure child pays attention to screen and sees reward at time 0
- No means of evaluating whether the child understands relationship between pressing button and receiving reward; younger children sometimes seemed to press at random
- RewP may not be elicited in 3-year-old group

Future Directions

- Determine whether Doors Task elicits a RewP in 3-year-olds
- Determine when RewP gender differences do become apparent
- Extend RewP study to children with divergent trajectories, particularly children with autism spectrum disorder (ASD)
- Understanding the difference between typical and divergent reward processing in children could illuminate function of reward processing in autism, leading to more effective intervention

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Acknowledgments and Correspondence

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