Influence of Delay on Electrophysiological Correlates of Memory during Early Childhood

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Introduction

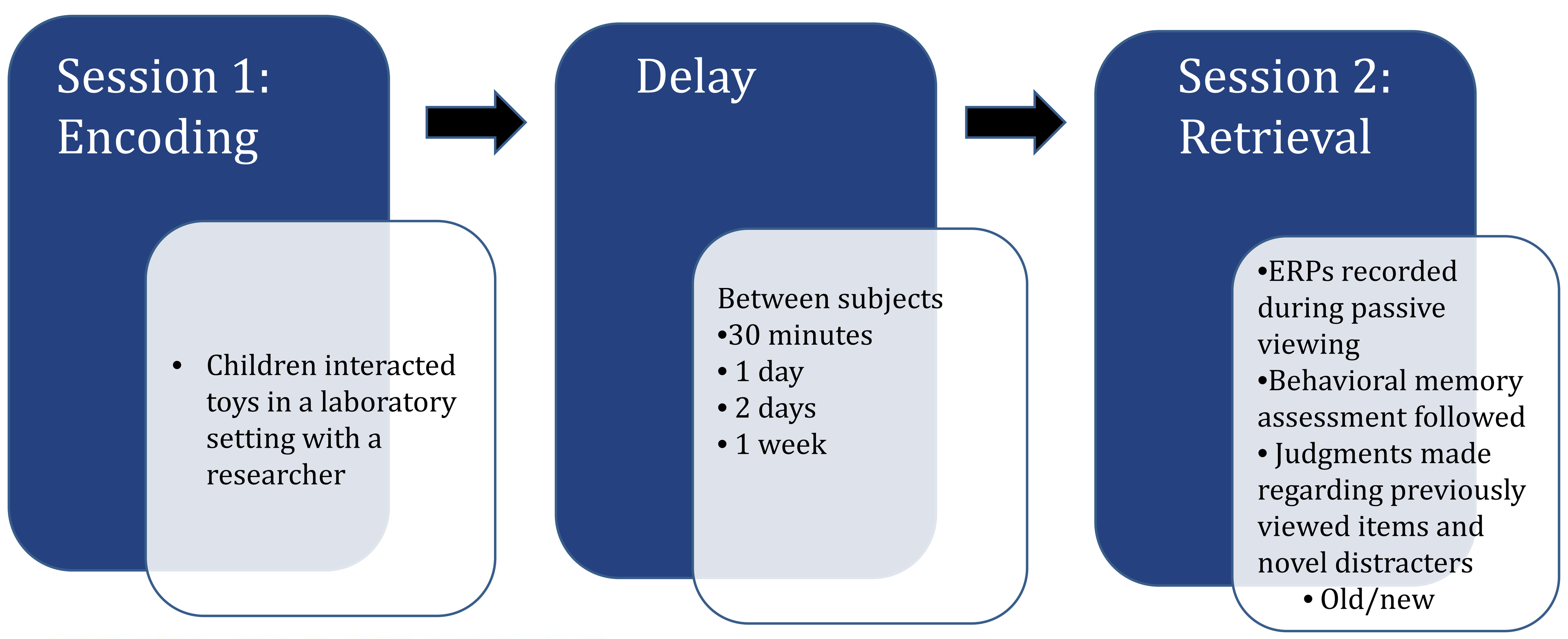
- Early childhood represents a period of rapid memory development (e.g., Drummey & Newcombe, 2002; Riggins, 2014).
    - For example, with age, children are able to retain information over increasingly long delays (e.g., Baker-Ward, Gordon, Ornstein, Larus, & Clubb, 1993)
- Event-related potential (ERP) studies have begun to address neural mechanisms underlying these changes at encoding (Rollins & Riggins, 2013) and retrieval (e.g., Marshall, Drummey, Fox & Newcombe, 2002; Riggins & Rollins, 2015; Riggins, Rollins, & Graham, 2013) during early childhood.
- However, we still know little about how factors that may influence memory (e.g., delay duration, encoding manipulations, stimulus type) affect the neural response.
- The goal of the present analyses was to examine the effect of delay on ERPs at retrieval.

Methods

Participants

- Children from three memory studies participated in similar tasks. Retrieval was assessed following a delay of:
    - 30 minutes (n = 22, M = 5.08 ± .61 years, 7 males)
    - 1 day (n = 32, M = 4.74 ± .54 years, 20 males)
    - 2 days (n = 19, M = 4.75 ± .52 years, 9 males)
    - 1 week (n = 40, M = 5.56 ± .28 years, 16 males)

Memory Paradigm



Event-Related Potentials (ERPs)

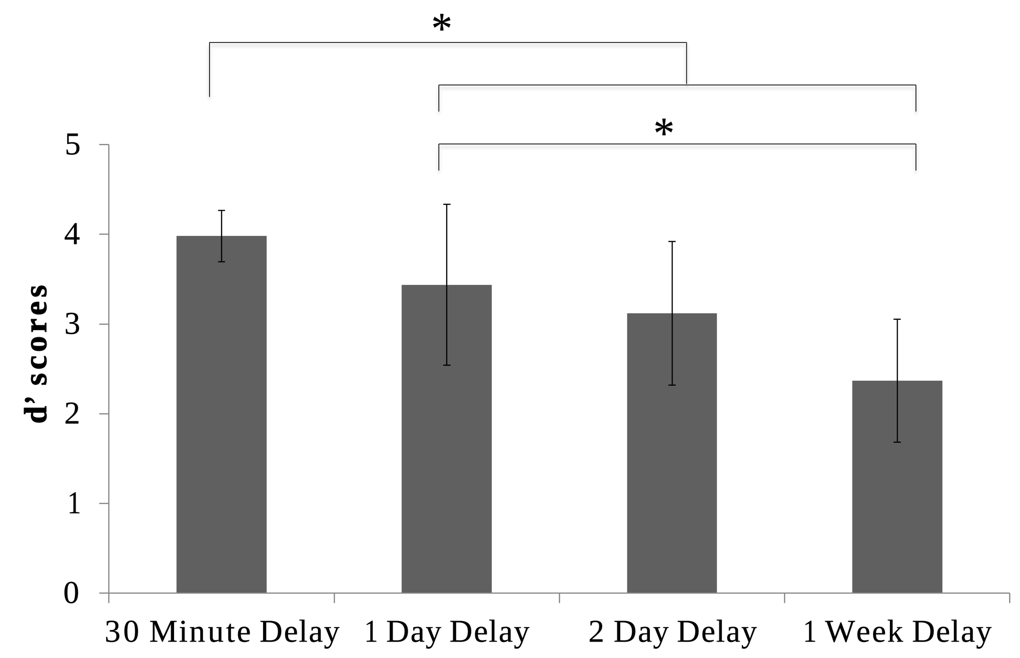
- EEG was recorded with a sampling rate of 512 Hz (BioSemi Active 2) from 64 active Ag-AgCl scalp electrodes and two vertical and two horizontal electrooculogram (EOG) channels.
- EEG data were re-referenced offline to an average reference configuration using Brain Electrical Source Analysis (BESA) software (MEGIS Software GmbH, Gräfelfing, Germany).
- Ocular artifacts were corrected applying the Ille, Berg, & Scherg (2002) algorithm.
- Trials were hand-edited to remove movement related artifact.
- Data were high and low pass filtered at 0.1 Hz and 40 Hz, respectively.
- A minimum of 10 trials were required per condition.
- Trials were epoched with a 100ms baseline and continued during stimulus presentation for 1500ms at two epochs: 350-500 ms and 800-1100 ms.

Results

Behavioral Performance (Figure 1)

- Delay significantly influenced children's ability to discriminate between old and new items, $F(3, 109) = 11.37$, $p < .001$.
- Delay had a larger impact on accurate recognition of previously encountered items, $F(3, 109) = 5.21$, $p = .002$, than correct rejection of novel items, $F(3, 109) = 1.63$, $p = .19$.

Figure 1: Behavioral Performance

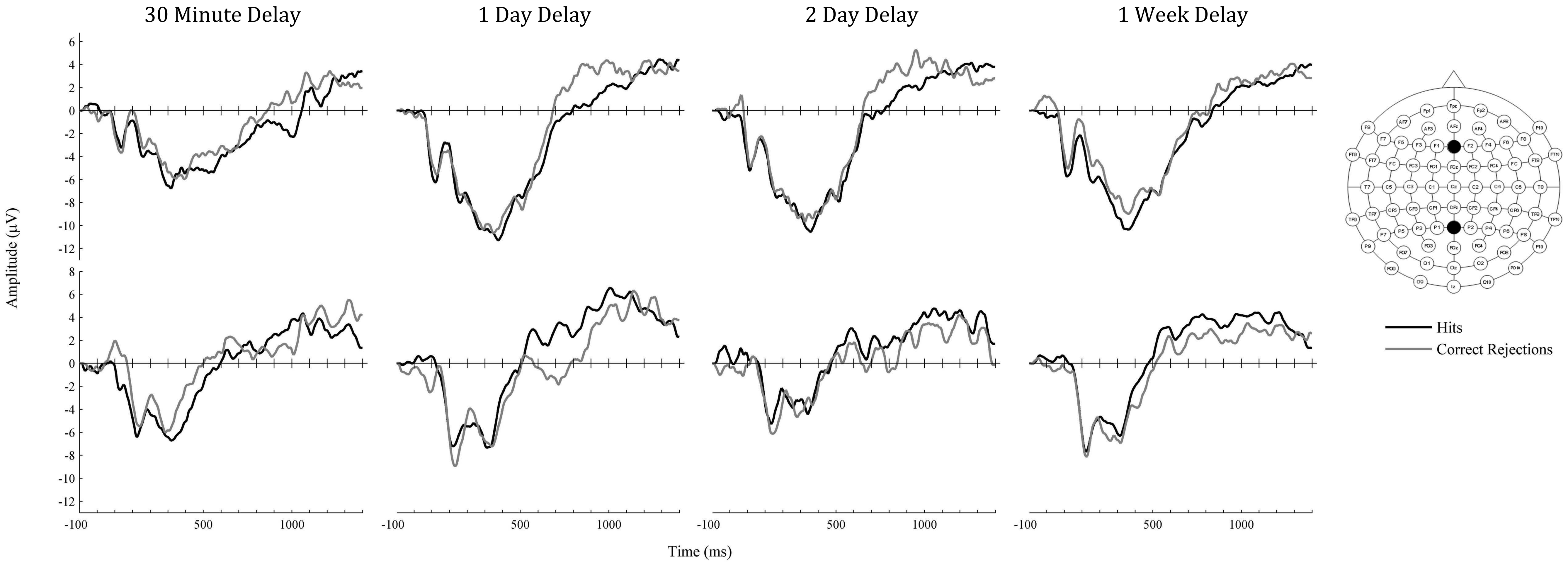


ERP Data (Figure 2)

4 Delay x 2 Condition (hits, correct rejection) x 7 Sagittal Plane x 5 Coronal Plane

- **350-500 ms**
    - Delay, $F(3, 109) = 6.54$, $p < .001$
        - Smaller amplitude for 30 min. vs. 1 day or 1 week delay
    - No significant memory effects
- **800-1100 ms**
    - Delay, $F(3, 109) = 8.17$, $p < .001$
        - Smallest amplitude with 30 minute delay
    - Condition x Sagittal Plane x Coronal Plane interaction, $F(24, 2616) = 10.78$, $p < .001$
        - Frontal and fronto-central: more positive amplitude to correct rejections than hits (CR > H)
        - Centro-parietal: right similar to pattern over frontal /fronto-central, midline and left similar to pattern over parietal
        - Parietal: more positive amplitude to hits than correct rejections (H > CR)

Figure 2



Discussion

- Memory performance decreased across longer delays
- ERP responses to old and new items are similar across delays ranging from 30 minutes to one week, suggesting similar neural processes engaged overtime
- Overall amplitudes tended to be smaller at shorter delays
- Future research is needed to investigate other factors that may influence neural and behavioral correlates of memory such as incidental vs. intentional encoding, depth of encoding, and stimulus type (e.g., 2-D images vs. photographs of objects)

Acknowledgements

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