Electrophysiological Correlates of Recollection and Familiarity at Encoding

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Introduction

• Although the ERP response associated with *retrieval* has been extensively assessed in adults (see Friedman & Johnson, 2000; Yonelinas, 2002 for reviews), ERP responses at encoding have not been as comprehensively studied (Wagner, Koutstaal, & Schacter, 1999).

• Some research supports the neural dissociation of recollection and familiarity at encoding in adults (Duarte, Ranganath, Winward, Hayward, & Knight, 2004; Friedman & Trott, 2000; Mangels, Picton, & Craik, 2001; Yovel & Paller, 2004), but inconsistencies within the literature are present (Friedman & Trott, 2000; Guo, Duan, Li, & Paller, 2006; Smith, 1993). These inconsistencies may be due to the use of objective versus subjective measures of memory.

•Some research suggests that a subsequent memory effect may be present in infancy (Bauer et al., 2006), no research has assessed whether recollection and familiarity are neurally dissociable in early childhood. The main goal of the current study was to examine the processes of recollection and familiarity in childhood during encoding.

•Additionally, this study was interested in the relation between the processes of recollection and familiarity and performance on executive function tasks that are assumed to recruit the prefrontal cortex, a brain region shown to be recruited during memory encoding and retrieval in adults (Yonelinas, 2002).

Methods

Participants

- Behavioral and ERP data was collected from 38 6-year-old children (20 boys and 18 girls, mean age = 6.51 ± .27 years, range = 6.03-6.95). Data analyses included 20 children with complete behavioral performance and a minimum of 10 ERP trials per condition.

Behavioral Assessment

- The study required one 2-hour visit to the Neurocognitive Development Lab at the University of Maryland. hour
- Stimuli included 180 animals and common objects from colored Snodgrass and Vanderwart line drawings (Rossion & Pourtois, 2004) and external sources with comparable image coloration and visual complexity.
- Encoding (see Figure 2)
  - Size and Fit blocks
- Retrieval
  - Old/new
  - Task performed at encoding

Figure 1

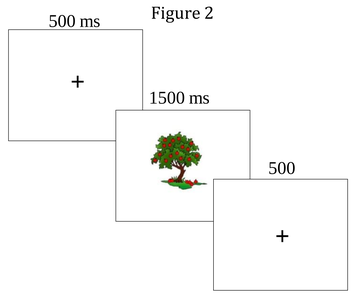
Event-Related Potentials (ERPs)

- 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 (see Figure 1)
- 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 80 Hz, respectively.
- Trials were epoched with a 100ms baseline and continued during stimulus presentation for 1500ms at three epochs: 250-400 ms, 500-800 ms, 800-1200 ms .
- ERPs were sorted based on memory performance on the behavioral paradigm. Conditions included recollected, familiarity, later remembered, and missed items.

Neuropsychological Assessments

- Memory
  - Narrative Memory (NM; NEPSY-II)
- Executive functioning
  - Inhibition (NEPSY-II)
  - Word Generation Task (NEPSY-II)
- General Intellectual Ability
  - Vocabulary (WPPSI-III)
  - Block Design (WPPSI-III)

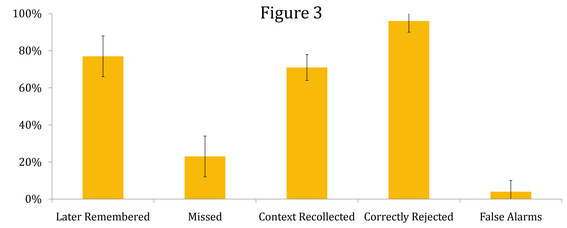
Figure 2



Behavioral Data (Figure 3)

- Statistical analysis revealed no differences in encoding or memory performance between the animacy and size tasks. Therefore, all subsequent analyses collapse performance across the two tasks.

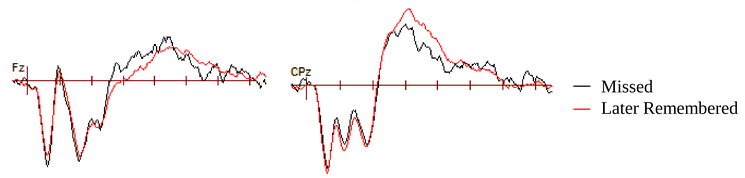
Figure 3



ERPs

- Mean ERP amplitudes were assessed using repeated measures ANOVAs at midline and lateral electrode sites
- Remembered/Missed Times
  - For the 250-400 and 800-1200 ms time window, no significant main effect or interaction with condition was present in the omnibus ANOVA for the midline or lateral leads.
  - 500-800ms (see Figure 4).
    - Midline leads there was an interaction between coronal plane and condition. F(5, 95) = 4.7 , p< .01
    - Condition main effects occurred at Fz, F(2,19) = 5.9, p<.01, and CPz, F(1, 19) = 5.45, p<.05
    - The polarity of the effect was reversed at frontal and centro-parietal leads. At Fz, the mean amplitude of the remembered items (-3.50 μV) was more negative than the mean amplitude of the missed items (-1.66 μV). However, at CPz the mean amplitude of the remembered items (5.14 μV) was more positive than the mean amplitude of the missed items (3.24 μV).
    - Similar effects were observed at the lateral leads.

Figure 4



- Recollected/Familiar/Missed
  - Despite children's high levels of recollection performance, electrophysiological data was approximately similar for subsequently recollected and familiar items.

Neuropsychological Assessments

- 1 participant was excluded from correlational analyses due to having a NM Free Recall score of zero (due to extreme shyness the child refused to participate in this task) which was >2 SD from the mean.
- Memory Paradigm and Narrative Memory Task (Figure 5)
  - Narrative Memory Free Recall was positively correlated with the percentage of items correctly identified as old, $r(19) = .43$, $p < .05$.
  - Relation to general intellectual ability (Figure 6)
    - Vocabulary was positively related to Narrative Memory Recognition, the simplest level of the Narrative Memory Task, $r(18) = .57$, $p<.05$.

Figure 5

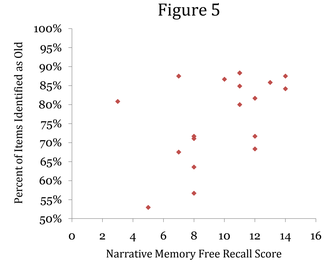
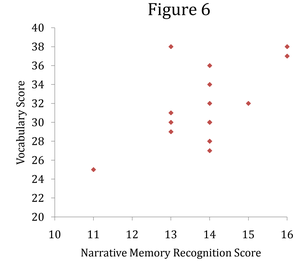


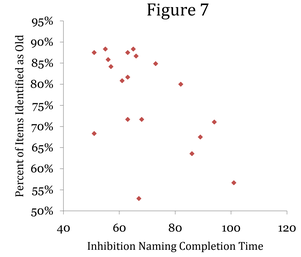
Figure 6



Neuropsychological Assessments cont.

- There were no significant correlations between performance on tasks that tapped executive functioning (i.e., Inhibition and Word Generation Tasks).
- Completion time on the Naming portion of the Inhibition Task was related to the percentage of items correctly identified as old, r(19) = -.56, p<.05.
  - In sum, faster completion of the Naming Test, indicative of greater processing efficiency, was related to more accurate performance on the experimental memory paradigm (Figure 7).

Figure 7



ERP Difference Scores and Behavioral Measures

- At P2, larger differences between items later remembered and missed was positively related to the percentage of items correctly identified as old, $r(19) = .47$, $p<.05$. (Figure 8)
- Similarly, at FC5 larger differences between items later remembered and missed were related to an increased number of details remembered during NM Free Recall, $r(19) = -.50$, $p<.05$, as well as NM Free and Cued Recall at FC5, $r(19) = -.64$, $p<.05$ (see Figures 9 &10).

Figure 8

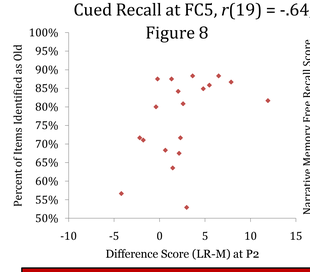


Figure 9

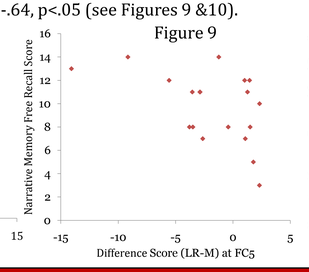
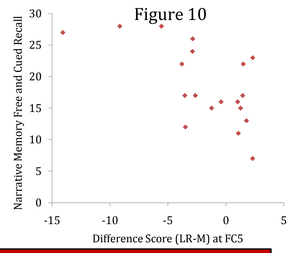


Figure 10



Discussion

ERPs at Encoding are Related to Memory performance at Retrieval

- Consistent with previous studies, remembered items elicited a more positive-going waveform in comparison to missed items at centro-parietal leads (see Wagner et al., 1999 for a review).

Recollection/Familiarity Effect

- ERP studies using the remember/know paradigm or similar methods have reported differences between recollection and familiarity (Friedman and Trott. 2000; Mangels et al., 2001; Yovel & Paller, 2004, c.f. Smith, 1993;). However, studies using objective measures of memory performance have not discerned a difference between recollection and familiarity at encoding (Guo et al., 2006; Friedman & Trott, 2000).

Memory and Executive Functions

- Future investigations should be conducted to discern the relationship between memory and executive function using a battery of executive function tasks assessing working memory, inhibitory control, and cognitive flexibility, skills hypothesized to be central to executive functioning (Diamond, 2006).

Acknowledgements

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