An Investigation of Recollection and Familiarity in Early Childhood

Meghan Graham & Tracy Riggins
University of Maryland, College Park
Department of Psychology
Neuroscience and Cognitive Science (NACS) Graduate Program

Introduction

- According to dual-process models of memory, two different cognitive processes are involved in recognition memory:
  - Familiarity-a general sense of having seen something before
  - Recollection-retrieving contextual details about the when or where the item was encountered (e.g., Yonelinas, 2002).
- These processes engage separable networks in the adult brain, that can be detected using event-related potentials (Friedman & Johnson, 2000).
- Evidence suggests that during middle childhood, familiarity develops earlier than recollection (e.g., Cycowicz, et al.,2001; Czernochowski et al., 2005; Drummey & Newcombe, 2002). However, few studies (e.g., Riggins et al., 2009) have examined memory in terms of dual processes in early childhood.
- Marshall and colleagues (2002) found an ERP old-new effect in 4-year-olds but did not examine any differentiation between familiarity and recollection.
- This study uses a novel behavioral paradigm and event-related potentials (ERPs) to examine memory processing in early childhood within a dual-process framework.

Method

Figure 1

Participants

• Behavioral and ERP data was collected from a total of 39 children. These analyses Examine a subset of 17 children (10 male, 7 female) between 5 and 6 years of age, for whom both behavioral data and a minimum of 19 artifact-free ERP trials with the expected overall waveform morphology per condition were available.
Mean age for this subset= 5.62 years (Range: 5.04- 6.06 years)
• Children made 2 visits to the lab, approximately a week apart
Mean delay 6.59 days (range 5-8 days)

BEHAVIORAL

Visit 1 - Encoding:
• Children were shown 2 sets of 30 items (total =60 items) each in 2 different contexts (Figure 1).
• An experimenter showed the child each item one at a time, as well as an action associated with the item, which the child then imitated.
• Items were matched across sets, the order of item presentation was randomized and the order of the contexts was counterbalanced.

Visit 2 - Retrieval:

• Children first completed the ERP portion of the experiment (see below).
• Following ERP collection, children were presented with the 60 target items they had seen on their first visit as well as 30 novel distracter items.
• If an item was identified as having been seen the week before, children were asked to place the item into the context in which they had encountered it on their first visit, or to place items into a "new item" bin if they had not seen the item on their first visit.

Figure 2

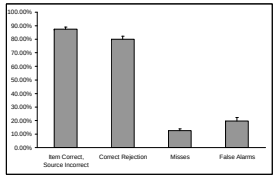
Event-Related Potential (ERP)

• Event-related potentials (ERPs) were recorded from 64 scalp locations, plus two vertical electrooculogram (EOG) and two horizontal EOG channels using active Ag–AgCl electrodes (BioSemi Active 2) while children viewed pictorial stimuli on a computer screen (Figure 2).
• Children participated in 2 blocks. Each block consisted of random presentation of the previously seen (target) items and 30 new (distracter) items (total trials = 180).
• ERPs were sorted based on behavioral performance, such that grand average. ERPs were generated for correctly identified old items in the correct context, correctly identified new items in the incorrect context, and correctly rejected new items.
• ERPs were filtered (high-pass at 0.1 Hz, 6B/octave, low-pass at 80 Hz, 24 dB/octave) and referenced offline to an averaged reference.
• Based on visual inspection and Marshall et al (2002), we selected 3 time windows for analysis: 300-600 ms, 600-900 ms and 900-1500 ms.
• Average amplitude was extracted for each time window. Analyses included RMANOVA on data from 5 midline leads (3 condition x 5 midline leads). Laterality differences were examined via a RMANOVA on 6 lateral leads (3 condition x 2 hemisphere x 3 coronal plane). (See Figure 5.)
• Only main effects or interactions with condition are reported.

Results

BEHAVIORAL (Figures 3 and 4.)

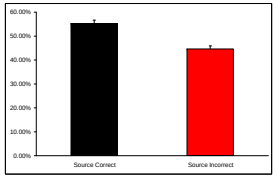
Figure 3



• 87.55% of the previously-seen target items were correctly identified as old
• 80.00% of the new distracter items were correctly identified as new.
• Out of the target items that were correctly identified, 55.38% were sorted to the correct context, t(16) =3.011, $p<.05$.
• The miss rate was 12.45% and the false alarm rate was 19.80%.

ERP (Figures 5-8.)

Figure 4



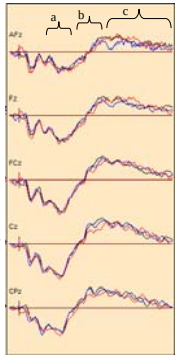
Window 1: 300-600 ms

• MIDLINE LEADS (Figure 6): No significant effect.
• LATERAL LEADS: Marginal 3-way interaction between condition, hemisphere, and coronal plane, $F(4,64)=2.56$ $p=.06$. Follow-up analyses revealed that for source incorrect items, average amplitude differed in the left and right hemispheres in the frontal plane (F3= -7.45 µV, F4= -9.56 µV).

Window 2: 600-900 ms

• MIDLINE LEADS (Figure 6): Significant main effect of condition, $F(2,32)=3.63$ $p<.05$. Pairwise comparisons indicated that average amplitude to "source correct" items was significantly different from "correctly rejected, new" items, $p<.05$. (Figure 7.)
• LATERAL LEADS: Significant 3-way interaction, $F(4,64)=2.78$ $p<.05$. Follow-up analyses indicated that in the left and right hemisphere average amplitude differed as a function of coronal plane.

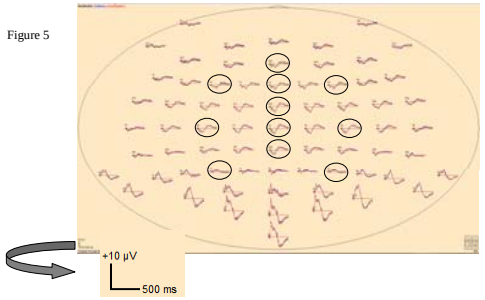
Figure 6: a-300-600 ms, b-600-900 ms, c-900-1500 ms



Window 3: 900-1500 ms

• MIDLINE LEADS (Figure 6): No significant effect.
• LATERAL LEADS: Significant 3-way interaction, $F(4,64)=2.91$ $p=.05$. Follow-up analyses indicated a marginal main effect of condition in the right (but not left) hemisphere, $F(2,32)=2.88$ $p=.08$ (Figure 8)

Figure 5



RELATIONS BETWEEN BEHAVIORAL AND ERP MEASURES

• Correlations between proportion source correct and average amplitude at P4 in the 900-1500 ms window were found for both item and source correct (r=-.49, $p<.05$) and item correct source incorrect (r=-.53, $p<.05$)

Results (continued)

Figure 7

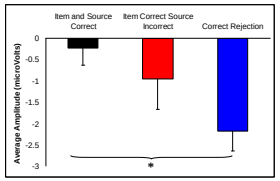
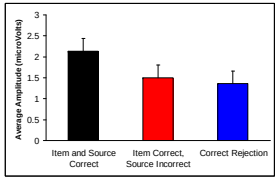


Figure 8



Discussion

• This study used a novel behavioral paradigm in combination with ERPs to examine memory in early childhood within the context of a dual-process memory model. The correct identification of viewed items and their contexts was taken to indicate the use of recollective processes, while the correct identification of items without the correct identification of their sources was used as an index familiarity-based recognition. The 'event-related' paradigm allowed ERPs to be sorted based upon behavioral performance, such that ERPs associated with "recollection" and "familiarity" could be compared.

• The behavioral results indicate that after a delay of 1 week, children were able to remember previously-seen items and their contexts at levels above chance.

• The interaction found in the 300-600 ms window shows differences between the right and left hemispheres for familiar, but not recollected items.

•They further suggest an old-new effect specific to recollection of items and their source within the 600-900 ms window with a fronto-central midline distribution.

• In the 900-1500 ms window, there was a marginal effect of condition in the right but not left hemisphere, with recollected, but not familiar items, showing decreased negativity relative to new items.

•Taken together, these findings suggest that there may be differential processing of recollected and familiar items in early childhood.

• Data collection using this paradigm is ongoing. Future analyses will examine data from all lateral leads. In addition, comparisons will be made between children who were low-performing (i.e., below chance) and those who were high-performing (i.e., above chance).

References

Cycowicz, Y. M., Friedman, D., Snodgrass, J. G., & Duff., M. (2001). Recognition and source memory for pictures in children and adults. *Neuropsychologia, 39*, 255-267.

Czernochowski, D., Mecklinger, A., Johansson, M., Brinkmann, M. (2005). Age-related differences in familiarity and recollection: ERP evidence from a recognition memory study in children and young adults. *Cognitive, Affective, & Behavioral Neuroscience, 5(4)*, 417-433.

Drummey, A.B. & Newcombe, N.S. (2002). Developmental changes in source memory. *Developmental Science, 5*, 502-513.

Friedman, D. & Johnson, R. (2000). Event-related potential (ERP) studies of memory encoding and retrieval: a selective review. *Microscopy Research and Technique 51*, 6-28.

Marshall, D.H., Drummey, A.B., Fox, N.A. & Newcombe, N.S. (2002). An event-related potential study of item recognition memory in children and adults. *Journal of Cognition and Development 3(2)*, 201-224.

Riggins, T., Miller, N. C., Bauer, P. J., Georgieff, M. K., & Nelson, C. A. (2009). Electrophysiological indices of memory for temporal order in early childhood: Implications for the development of recollection. *Developmental Science, 12(2)*, 209-219.

Yonelinas, A. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language, 46*, 441-517.

Acknowledgements

The authors would like to thank the families who participated in this study and the members of the Neurocognitive Development Lab, especially Leslie Hainley, for assistance with data collection and analysis.
Support for this research was provided by the Department of Psychology at the University of Maryland, College Park.