Do perceptual item features matter for children and young adults? Behavioral and ERP correlates of familiarity and recollection for perceptually changed versus identical pictures

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Introduction
Dual-process models of recognition memory assume that two independent processes underlie episodic memory retrieval: Recollection and familiarity. In event-related potentials (ERPs), two putative neural correlates of these processes have been identified in young adults. A parietal positivity about 500–600 ms following stimulus presentation is associated with recollection, whereas a mid-frontal positivity after about 300–500 ms is related to familiarity [1,2]. However, the developmental trajectory for both processes and the relative contribution of conceptual and perceptual processes remain open to further investigation.

Despite considerable age differences in behavioral performance during source memory tasks (e.g., 3,4), ERP correlates of recollection have consistently been demonstrated for correctly identified perceptual and conceptual item repetitions in children and young adults [4-6]. By contrast, previous findings are mixed with respect to age-related differences in the ERP correlates of familiarity. For young adults, previous research has shown that familiarity is an amodal and global-matching process, and hence not only found in perceptually identical stimuli, but also when stimuli are conceptually related (6,9). However, so far early mid-frontal ERP old/new effects associated with familiarity in young adults have not been observed for children [4,6] unless a speeded old/new response was required for identical item repetitions [7]. Hence, a potential precursor of familiarity in children might largely depend on perceptual stimulus features. Moreover, in two recent studies, children and adolescents showed a partial old/new difference to this time window (4,6). However, the functional relevance of this early parietal old/new effect is currently open.

Here, we investigated to what extent identical versus changed item features modify behavioral and ERP correlates of recognition memory in each age group. During incidental learning, adults as well as older and younger children decided whether visually presented stimuli were more commonly found indoors or outdoors. During test, participants classified each picture as perceptually identical, changed, or completely new. Next, study and test phases were repeated under explicit encoding instructions.

We expected performance benefits for identical relative to changed pictures across age groups. While incidental encoding should be sufficient to support simple old/new decisions, young adults in particular were expected to benefit from intentional encoding for the retrieval of specific perceptual item features. For children, we predicted lower differences between incidental and intentional encoding, due to an inherent focus on perceptual rather than abstract item attributes. Thus, we did not expect age-related differences in memory for perceptual features.

For both perceptually changed and identical item repetitions, we predicted ERP correlates of recollection in all age groups. Mid-frontal ERP correlates of familiarity were expected for perceptual and conceptual item repetitions for young adults. Specifically, we assessed whether old/new effects in this time window vary across ages.

Methods
Participants:
- 23 children in 1st grade (7 – 9 years, mean = 7.5, SD = 0.3)
- 23 children in 2nd grade (9 – 11 years, mean = 10.5, SD = 0.4)
- 19 undergraduate students (20 – 23 years, mean = 21.4, SD = 1.1)

Procedure:
- Phase 1: Incidental study phase
- Phase 2: Intentional study phase
- Test phase 1
- Test phase 2
- 1200 items

Analyses:
- Item Hits: Item correctly identified as “old”
- Feature Hits: Item correctly identified as “same” or “different”, respectively

Results
As predicted, an overall age difference in performance was observed.

In age groups, performance was worse for changed versus identical item repetitions. Behavioral old/new accuracy was higher for identical items compared to changed ones (self judgments), but memory for perceptual item features in older children was better following intentional encoding for both young and older children. In fact, no differences between identical and changed item repetitions could be observed for older children.

In both time windows, partial old/new differences were observed for both item types, with slightly larger amplitudes for identical compared to changed item repetitions.

Topographical maps illustrate the distributions of ERP old/new effects in Phase 1. Old/new differences were only observed for both item types and times windows for young children, as in older children, early parietal old/new effects were not observed. Whereas later recollection effects were consistently observed across conditions. For young children, both early and late familiarity and late partial old/new effects were larger for identical compared to changed item repetitions.

Discussion
Item memory was supported by incidental encoding in all age groups. By contrast, only older children spontaneously encoded sufficient perceptual details to differentiate between identical and changed pictures in Phase 1, suggesting that older children base their old/new decisions to a larger extent on perceptual relative to conceptual item information irrespective of encoding instructions. Following intentional encoding in Phase 1, memory feature improved for both younger children and young adults, suggesting that all age groups were able to retrieve relevant perceptual item details successfully.

In line with previous findings [4,6] and the high behavioral performance observed here, partial ERP correlates of recollection (500 – 650 ms) were found across age groups, and consistently larger for identical compared to changed items. By contrast, mid-frontal ERP correlates of familiarity (350 – 500 ms) were only observed for young adults for both identical and changed item repetitions. By contrast, early ERP old/new effects in children had a parietal topography, and were reliable only for identical item repetitions in phase 2 for older children. Since early parietal old/new effects were observed inconsistently in older children, and for both identical and changed item repetitions in younger children, a perceptually based precursor of adult familiarity seems unlikely.

Together, behavioral and ERP findings suggest age differences in the specific retrieval strategy adopted by each group. Young adults appear to rely predominantly on conceptual item information unless prompted to focus on relevant perceptual features. ERP correlates suggest that their responses are based on familiarity as well as recollection for both item types. By contrast, children might be more reluctant to take advantage of an item’s familiarity (in this case for time) due to the more complex control processes necessary to evaluate the relative strength of a familiarity signal, which might be difficult to translate into a response. Instead, at least older children base their old/new decisions to a larger extent on perceptual relative to conceptual item information. This retrieval of specific perceptual detail via recollection requires additional time and might contribute to children’s deliberately shown responses [7].

The present results are consistent with recent (MRI) data which did not find developmental differences in MTI activity during the memory retrieval of visual scenes. Instead, functional connectivity between PPC and MTI regions increased with age for successful retrieval [12], suggesting age differences in the control of memory retrieval.

References