Development of Subjective Recollection: Evidence from Event-Related Potentials

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Introduction

• In adults, ERPs at encoding and retrieval are sensitive to the recollection of contextual details. When recollection is indexed by Tulving’s remember/know paradigm (1985), the ERP amplitude differentiates “remember” versus “know” judgments (for reviews see Friedman & Johnson, 2000; Rugg & Curran, 2007).

• Developmental studies suggest that children as young as 6 years of age can reliably perform the remember/know paradigm (Ghetti, et al., 2011) and that recollection follows a longer developmental trajectory than familiarity (Ghetti & Angelini, 2008). However, the neural mechanisms that underlie these developmental trajectories remain relatively unexplored (cf. Ghetti et al., 2010).

• The goal of the current study was to assess age-related changes in ERPs associated with subjective recollection at encoding (Study 1) and retrieval (Study 2) in children, adolescents, and adults.

Behavioral Methods

Participants

• Study 1: Encoding

  • A total of 124 participants provided complete behavioral data for this study, 55 children (mean age = 7.63 years, SD = .75, 32 females, 23 males), 32 adolescents (mean age = 12.79 years, SD = .81, 18 females, 14 males), and 37 adults (mean age = 29.22 years, SD = 2.26, 20 females, 17 males). ERP analysis included 17 children, 24 adolescents, and 26 adults.

• Study 2: Retrieval

  • A total of 103 participants provided complete behavioral data for this study, 41 children (mean age = 7.44 years, SD = .56, 28 females, 13 males), 26 adolescents (mean age = 16.66 years, SD = .46, 18 females, 8 males), and 36 adults (mean age = 29.23 years, SD = 2.3, 23 females, 13 males). ERP analysis included 20 children, 19 adolescents, and 29 adults.

Behavioral Assessment

• The study required one 1.5-hour visit to the Neurocognitive Development Lab.

  • Stimuli included 180 animals and common objects from colored Snodgrass and Vandervart line drawings (Rossion & Pourtois, 2004) and external sources with comparable image coloration and visual complexity. Stimuli were colored red, green, and gray-scale using Microsoft PowerPoint.

  • Encoding (see Figure 2)

    ■ Four blocks (10 items/block)
    ■ Color judgment (random within block)
    ■ Size/anomaly judgment (alternating each block)

  • Retrieval (see Figure 2)

    ■ Old/new
    ■ Subjective recollection: Remember/Familiar
    ■ Objective recollection: Color of item
    ■ Objective recollection: Task performed at encoding

Electrophysiological Methods

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 mastoid reference using Brain Electrical Source Analysis (BESA) software (MEGIS Software GmbH, Grafing, Germany). Ocular artifacts were corrected applying the Ilic, Berg, & Scherg (2002) algorithm. Trials were hand-edited to remove movement related artifacts. 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.

Results

Behavioral Performance (3 Age Group x 2 Subjective Judgment x 2 Objective Judgment)

Study 1: Encoding

• Children had poorer memory for details than adolescents and adults; F(2, 116) = 6.18, p = .003

• Participants had better memory for the task than the color of the item; F(1, 116) = 17.38, p < .001

• Accuracy was higher when participants provided “remember” judgments; F(1, 116) = 41.77, p < .001

Study 2: Retrieval

• Participants had better memory for the task than the color of the item; F(1, 98) = 37.11, p < .001

• Children performed similar to other age groups on color but worse on task; F(2, 98) = 4.39, p = .02

• Accuracy was higher when participants provided “remember” judgments; F(1, 98) = 36.48, p < .001

• Children’s subjective judgments differentiated color but not task memory; F(2, 98) = 4.08, p = .02

Discussion

• No age-related changes were present in the ERP response associated with subjective recollection in Study 1 suggesting similarity of processing at encoding across age groups.

• At retrieval (Study 2), a recollection effect was absent in children, widespread in adolescents, and maximal in adults’ centroparietal leads.

• The increased localization of the effect at retrieval is consistent with previous developmental cognitive neuroscience studies and theories that conceptualize development as occurring due to the development of neural regions and their connectivity (e.g., Johnson, 2001).

• Future studies need to investigate which neural regions underlie the age-related differences present at retrieval.

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References


Note: Children in the ERP analyses for Study 2 had behavioral performance scores similar to children in Study 1.

ERP Data

Study 1: Condition 3 Condition x 3 Coronal x 3 Sagittal

Study 1: Encoding

• 700-900 ms

• Fix/Not fix? or Living/Not living?

• Children (p < .05), Adolescents (p = .05), Adults (p = .001)

Study 2: Retrieval

• 500–700 ms

• Age Group x Condition, F(4, 130) = 7.19, p < .001

• Age Group x Condition x Sagittal Plane, F(4, 260) = 2.86, p = .012

• Children

• Effect of or interaction with Condition

• Adolescents

• Condition, F(2, 36) = 7.3, p = .002

• Adults

• Condition, F(2, 36) = 7.1, p = .002

• Cond. x Sagittal, F(4, 112) = 4.89, p = .01

• Maximal over left centro-parietal leads

• 2400 ms

• 124 participants provided complete behavioral data for this study, 55 children (mean age = 7.30 years, SD = 1.04, 28 females, 27 males), 26 adolescents (mean age = 15.74 years, SD = 1.96, 16 females, 10 males), and 36 adults (mean age = 27.17 years, SD = 2.3, 20 females, 16 males). ERP analysis included 20 children, 19 adolescents, and 29 adults.

Figure 1

Behavioral Data

Old/New

Remember/Familiar

Superbizi/Unfilled

Figure 2

Encoding

500 ms

1500 ms

Red/Green

Fi/Not fit? or Living/Not Living

500 ms

Retrieval

Old/New

Remember/Familiar

Superbizi/Unfilled

If participant says the item is “new”,

Note: Children in the ERP analyses for Study 2 had behavioral performance scores similar to children in Study 1.