Trade-Offs in Posterior Hippocampus versus Medial Prefrontal Cortex Mechanisms Underlie Memory Precision in Childhood

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Abstract

Hippocampal subregions and medial prefrontal cortex may differentially shape memory precision in the mature brain: While anterior and posterior hippocampus may store the general themes and specific details of an episode, respectively, medial prefrontal cortex may instead connect related memories. However, given continued change to the functionality of these regions beyond childhood, it is unclear how children's memory precision is influenced by these same mechanisms. We characterized how hippocampal subregions and medial prefrontal cortex separately and in tandem encourage memory precision in childhood versus adulthood. Children (7-9 years old) and adults studied scene photographs and then performed a recognition test that included both the studied scenes and highly similar lures. Behaviourally, adults had more precise memories than children in that they were better able to discriminate studied scenes from lures. At the neural level, anterior hippocampus and medial prefrontal cortex were differently engaged during this memory formation: Anterior hippocampus engagement was related to subsequent memory across age groups, while children showed greater medial prefrontal cortex engagement than adults overall when studying scenes. Considering individual differences in engagement revealed further developmental differences. Children showed evidence for a trade-off in their reliance on posterior hippocampus versus medial prefrontal cortex during precise memory formation, suggesting competition between these regions. By contrast, the same structures in adults played a more cooperative role in supporting memory precision. These findings suggest that the relationship between posterior hippocampus and medial prefrontal cortex reverses over development to yield adult-like memory precision, such that these regions work in opposition in childhood before becoming specialized to cooperatively encourage precision in adulthood.

Keywords: encoding; memory discrimination; fMRI; adults

Introduction

The ability to form precise (high-fidelity) memories allows us to both vividly recollect events and to discriminate those events from other highly similar ones (Amer & Davachi, 2023; Yassa & Stark, 2011). Memory precision shows substantial improvement throughout development, evidenced by age-related increases in the discrimination of memories from similar lures (Ngo et al., 2019; Rollins et al., 2023; Rollins & Cloude, 2018). Recent work suggests this improvement is attributed to the development of hippocampal mechanisms (Canada et al., 2019; Lee et al., 2014), particularly how anterior and posterior subregions store contextual details (DeMaster & Ghetti, 2013; Ghetti et al., 2010; Sastre et al., 2016). Other work hints at these improvements being linked to age-related changes in medial prefrontal cortex (mPFC) mechanisms (Chai et al., 2014; Riggins et al., 2016; Varga et al., 2025) and how they emphasize commonalities across different experiences (Varga et al., 2025). Yet, it remains unknown how hippocampal subregion and mPFC mechanisms together support memory precision in childhood. Here, we characterized how these mechanisms yield memories that vary in precision among 7–9-year-old-children versus adults.

Together, hippocampal subregions can store a single experience at varying levels of precision in the mature brain (Brunec et al., 2018; Collin et al., 2015; Poppenk et al., 2013; Strange et al., 2014). Anterior hippocampus (aHPC) may emphasize the general themes of an experience (Evensmoen et al., 2013; McAndrews et al., 2016) and encourage imprecision, as reflected by memory errors to similar yet new experiences (e.g., Garoff-Eaton et al., 2006; Vijayarajah & Schlichting, 2023). Posterior hippocampus (pHPC) may instead emphasize detailed (perceptual) features (Brunec et al., 2018; Schlichting et al., 2015) and enable accurate recollection (McCormick et al., 2015; Poppenk & Moscovitch, 2011). Adults' memory quality may therefore depend on both aHPC and pHPC memory schemes. In contrast, children's memory precision may not rely on both subregions. Children recruit pHPC for memory processes that instead recruit aHPC in adults (Ghetti et al., 2010; Nichols et al., 2023; Varga et al., 2025), suggesting aHPC-mediated memory may not emerge until after childhood. The later emergence of aHPC mechanisms may result from the protracted structural development of aHPC over pHPC (Ayoub et al., 2023; Gogtay et al., 2006; Insausti & Amaral, 2004; Lee et al., 2014). We therefore expect that children's memory precision will depend more on pHPC memories, even if these representations lack precision (as seen at the behavioural level; Rollins & Cloude, 2018).

How hippocampal subregions encourage precision over development when also considering mPFC influences is unclear. Like hippocampal subregions, mPFC mechanisms may also differently contribute to memory precision over development. In adults, mPFC may connect new memories to broader knowledge (Bartlett, 1932; Spalding et al., 2015), and thus yield erroneous memory generalizations to related experiences (Berkers et al., 2017; Warren et al., 2014). Whether mPFC similarly yields generalizations in childhood is less clear. Children's mPFC may not form connections across different memories because it fails to emphasize their

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commonalities (Varga et al., 2025), potentially due to age-related differences in prior knowledge (Fisher et al., 2015; Unger et al., 2016), the capacity to reactivate related memories (Schlichting et al., 2022), and/or the structural integrity of mPFC and hippocampus connections (Lenroot & Giedd, 2006; Sowell et al., 2003). Therefore, children's mPFC may not encourage generalizations in a similar manner to adults' mPFC. These factors may also preclude the region from influencing subsequent memory more broadly in childhood (Chai et al., 2014).

The relationship between mPFC and hippocampal subregions might also have important implications for how memory precision changes over development. In adults, mPFC and aHPC may play complementary roles in supporting imprecision: Interactions between the regions influence the degree to which aHPC (1) retrieves the general themes of an experience (McCormick et al., 2015), and (2) emphasizes the overlap among related memories (Tompary & Davachi, 2017). While comparatively less is known about the relationship between mPFC and pHPC, detailed memories from pHPC (e.g., Brunec et al., 2018) may build on the more abstract, high-level representations from mPFC. How these same associations may influence children's memory precision is unknown. The ongoing development of aHPC and mPFC connectivity in childhood (Calabro et al., 2020) makes it unlikely that these regions will show the same complementary association seen in adults. Instead, developmental stability in how pHPC encourages memory (Callaghan et al., 2021) may make mPFC and pHPC memory associations more consistent across age groups. Lastly, it is also possible that children instead rely on hippocampal subregions rather than mPFC irrespective of the memory quality, as children tend to recruit hippocampus more than mPFC during memory formation overall (Brod et al., 2017).

Here, we explored how hippocampal subregions and mPFC together store memories that vary in quality in children versus adults. We measured how these regions were engaged when participants were asked to form memories of different scene photographs for a later memory test. We used participants' responses in the subsequent memory test to characterize a behavioural measure of memory precision and identify neural mechanisms associated with the formation of memories of differing quality. Lastly, we asked how the relationship between hippocampal subregions and mPFC mechanisms supports memory quality in both age groups. We expected developmental differences in how hippocampal subregions and mPFC separately support memory quality. In particular, we anticipated developmental consistency in how pHPC yields precise memories and developmental differences in how aHPC and mPFC yield imprecision, reflecting that the protracted development of these regions constrains memory quality over development. We also expected age-related differences in how the association between aHPC and mPFC functions influences memory quality—particularly their role in forming imprecise memories.

Method

Participants

Forty-three adults (23 females, 20 males; mean=29.12 years, SD=3.29 years; 24-35 years old) and sixty-two children (31 females, 31 males; mean=8.66 years, SD=0.97 years; 7-9 years old) participated in this experiment. Participants were subsequently excluded from the final sample for early withdrawal (2 children); illness in the scanner (1 adult and 1 child); the later detection of a brain abnormality (1 child); having a Total Problems Score in the clinical range on the Child Behaviour Checklist/6-18 (2 children; Achenbach, 1991); and not meeting the data (7 children) or memory performance (7 children) thresholds described below. Participants provided consent/assent and were compensated for their time ($20 CAD per hour).

Stimuli

One hundred sixty-two photographs were presented in the experiment. The photographs depicted 18 different scene categories (9 indoor and 9 outdoor: bathrooms, bedrooms, classrooms, clothing stores, grocery stores, gyms, indoor swimming pools, libraries, movie theatres, amusement parks, beaches, city streets, farms, forests, outdoor construction sites, outdoor skating rinks, playgrounds, and zoos). The photographs were visually similar pairs identified using Google's similarity search feature and visual inspection. The assignment of photographs to encoding versus the memory test was counterbalanced across participants.

Design

Encoding Participants studied scene photographs during functional magnetic resonance imaging (fMRI). Photographs were presented one at a time for 2000ms followed by a jittered interstimulus interval (ISI; fixation; 4000-8000ms; Figure 1A). Participants were instructed to study each presented photograph for a later memory test. The task was broken up into three scanning runs of equal length (24 photographs per run), with fixation included at the beginning (4000ms) and end (8000ms) of each run to allow for stabilization and lag of the MR signal, respectively. Participants also completed blocks from an orthogonal baseline task with separate stimuli (not discussed here).

Memory Test and Behavioural Analysis Immediately following encoding, participants performed an old/new recognition memory test for the studied photographs (Figure 1A). The task was performed during fMRI scanning, but we only consider the behavioural data here. The test included all photographs presented at encoding (studied; 72), highly similar new photographs matched to each studied photograph (lures; 72), and new photographs depicting unrelated scene categories (unrelated new; 18). Photographs were presented one at a time and in a randomized order, such that either the studied photograph or its matched lure could have appeared

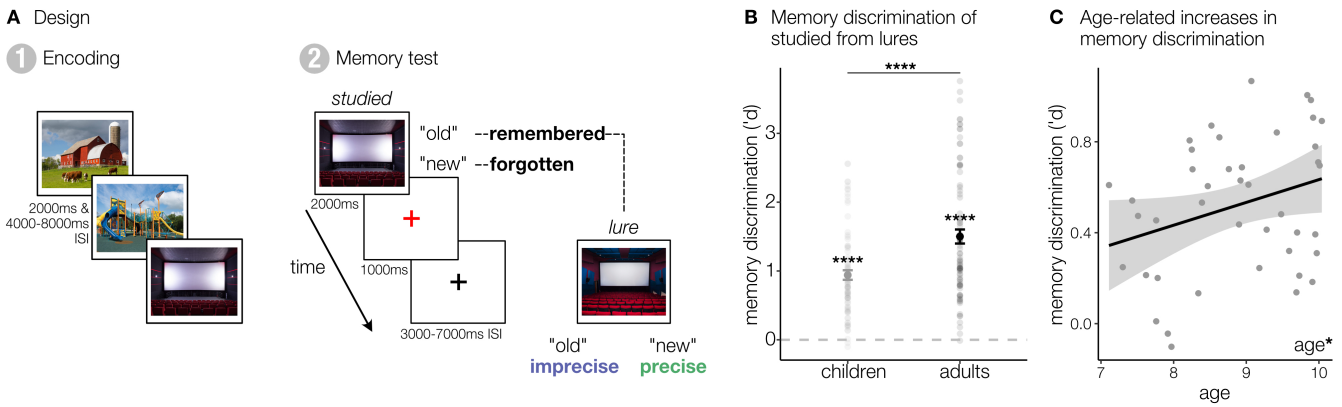

Figure 1: Task and behavioural results. (A) Depiction of the encoding (left) and memory test (right). Left: Example photographs shown at encoding. Participants viewed scene photographs presented consecutively for 2000ms followed by a jittered 4000-8000ms ISI. Right: Example photographs showed during the test. Participants viewed photographs from encoding (studied; depicted), new photographs that were highly similar to studied photographs (lures; depicted is the lure for the example studied photograph), and new photographs depicting unrelated scene categories (not depicted). Photographs at test were presented consecutively, with participants indicating whether each photograph was ("old") or was not ("new") seen at encoding. Responses to studied photographs and their lures were used to sort trials at encoding into one of three groups: For studied photographs that were later remembered, they were considered imprecise memories if the associated lure was endorsed as "old" and precise memories if the associated lure was endorsed as "new"; studied photographs that participants incorrectly responded "new" to were considered forgotten. (B) Subsequent memory discrimination (d') of studied photographs from lures (y-axis) as a function of age group (x-axis). Asterisks denote reliable d' from chance in each age group and the age group difference in d'. Larger circles represent group means; points are individual participants; error bars are 95% confidence intervals around the group mean. (C) Across-participants correlation of children's age (continuous measure; x-axis) and d' of studied from lures (y-axis). Points are individual participants and the band around the line represents the standard error. * $p<0.05$, **** $p<0.0001$

first. Participants indicated if the photograph had or had not been presented at encoding ("old" or "new", respectively) during the photograph presentation (2000ms) or during the subsequent response window (1000ms; followed by a 3000-7000ms ISI; Figure 1A).

We used participants' test responses to characterize our behavioural measure of memory precision—memory discrimination (d'; Banks, 1970) of studied photographs from lures. We also used test responses to lures to define neural engagement associated with precise and imprecise memory formation: Considering only studied photographs that were subsequently remembered, if its associated lure was correctly deemed as "new" (i.e., correctly rejected) the memory was considered precise, and if its associated lure was incorrectly endorsed as "old" (false alarm) the memory was considered imprecise (Figure 1A).

Neural Data Collection and Preprocessing

Functional data were collected in seventy-five whole-brain slices (oblique axial; oriented parallel to the ventral surface and adjusted for participants' brain coverage; repetition time [TR]=2000ms, echo time [TE]=30ms, flip angle=73°, 220 x 220 x 128mm matrix, 1.7mm isotropic voxels, multiband acceleration factor=3, GRAPPA factor=2; multi-band echo-planar imaging sequence). A structural T1-weighted 3D magnetization-prepared rapid gradient echo (MPRAGE; 256 x 256 x 160mm matrix, 1mm isotropic voxels) volume was also collected to perform co-registration and spatial normalization of the functional data to template space, along with a field map to correct for susceptibility distortion (TR=711ms, TE=4.92/7.38ms, flip angle=73°, 220 x 220 x 128mm matrix, 1.7mm isotropic voxels).

Preprocessing Data were preprocessed with fMRIPrep 20.2.1 (Esteban et al., 2018). All data were corrected for motion (MCFLIRT) and susceptibility distortion via the field map (EPI unwarping in FSL FUGUE), and then normalized to template space (MNI152NLin2009cAsym; boundary-based registration; BBREGISTER in FreeSurfer; Greve & Fischl, 2009). This process also yielded nuisance regressors we later included in our general linear models (GLMs; described below) to statistically remove the effects of motion from the data: the standard six motion parameters and their first temporal derivatives; framewise displacement (FD); and spatial standard deviation of successive difference images (DVARS; Power et al., 2012).

Participant and Data Exclusions

We excluded participants and functional runs based on motion and behaviour thresholds set *a priori*. Functional runs with high motion—i.e., one third of TRs had a FD>0.5mm or DVARS>1.5—were excluded from our analysis. Furthermore, participants with less than two functional runs in both encoding and the memory test after this motion exclusion were excluded from the final sample. We also excluded participants whose memory discrimination for studied versus unrelated new was numerically below 0.50 at test. We used a memory threshold concerning unrelated new over lures to ensure we selected participants with at least low-level memory for studied scenes without restricting

individual differences in lure discrimination.

Regions of Interest (ROIs)

We used anatomically defined hippocampus (divided into anterior and posterior subregions) and mPFC as our ROIs. Hippocampus and mPFC were delineated by hand on a 1mm isotropic MNI152 linear template based on anatomical landmarks. The hippocampus mask was further divided into thirds (anterior, middle, and posterior subregions) according to the number of slices along the anterior-posterior dimension. We did not consider the middle segment because we had no predictions concerning this segment. All ROIs were then moved to the template space of our functional data using ANTs nonlinear registration (Avants et al., 2011) and nearest neighbor interpolation.

Characterizing Neural Engagement Associated with Precise and Imprecise Memory Formation

We estimated neural engagement associated with subsequent precise, imprecise, and forgotten memories using GLMs. In each participant we first modelled neural engagement in each functional run separately for encoding trials that were subsequently remembered and associated to lures with (1) correct rejections (precise) or (2) false alarms (imprecise), and encoding trials that were (3) subsequently forgotten. Trials were modelled as events (2000ms long; matching their stimulus duration) and then convolved with the double-gamma hemodynamic response function. Temporal autocorrelation correction was applied to the models using FILM prewhitening. The models also included temporal derivatives and the 14 motion-related nuisance regressors calculated during preprocessing. These GLMs yielded participant-specific statistic images for encoding trials associated with precise, imprecise, and forgotten memories each, and for each run. Statistic images were then combined across runs within participants using higher-level GLMs (fixed effects; Woolrich et al., 2004) to extract each participant's average neural engagement for precise, imprecise, and forgotten memories at the condition level, separately in each ROI.

Comparing Neural Engagement during Memory Formation Between Age Groups and ROIs

Our approach to characterizing how hippocampal subregions and mPFC underlie memory quality in each age group was two-fold: Our first aim was to identify regions associated with subsequent memory and determine if these same regions supported memories of different quality. To do this, we first identified age group differences in each ROI's neural engagement related to (1) subsequent memory success by comparing engagement for later remembered (collapsed across precise and imprecise) versus forgotten trials; and (2) memory quality by comparing engagement for precise versus imprecise trials. Our second aim was to characterize how individual differences in the association between these regions may underlie subsequent memory success and quality. We correlated participants' average engagement in aHPC/pHPC with their average engagement in mPFC, separately for subsequently remembered (collapsed across precise and imprecise), forgotten, precise, and imprecise trials, and determined whether each association was cooperative (positive) or competitive (negative).

Results

Age-Related Improvements in Memory Precision

At the behavioural level, both children and adults showed reliable memory discrimination of studied scenes from lures (t-test from 0; children: t=11.20, p=4.52 x 10^{-14}, d=1.73; adults=13.60, p=8.48 x 10^{-17}, d=2.10; Figure 1B),

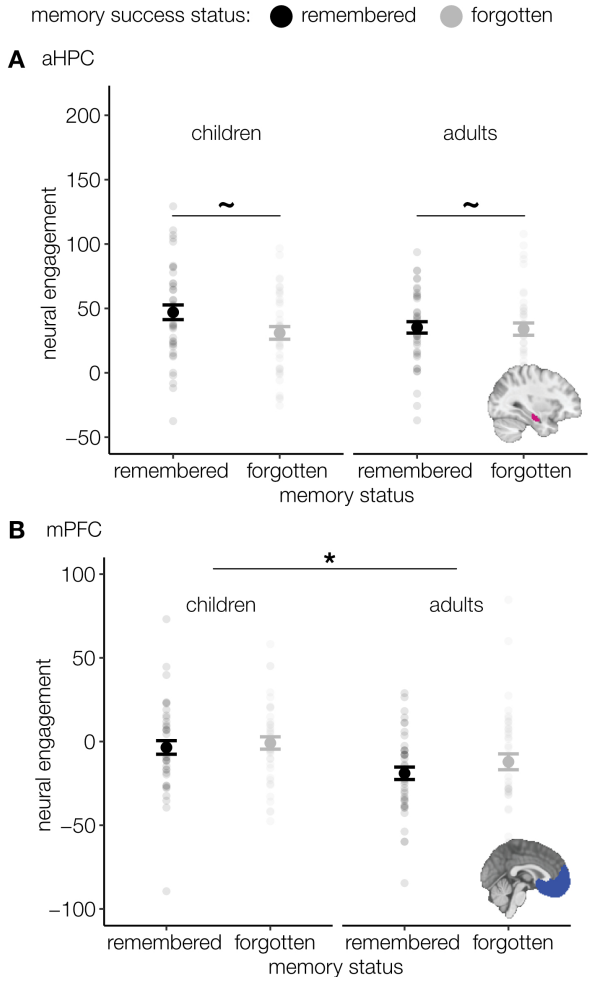

Figure 2. Neural engagement in aHPC and mPFC during subsequently remembered versus forgotten trials. (A) Anterior hippocampal engagement (univariate activation; y-axis) as a function of subsequent memory success (black: remembered; grey: forgotten) and age group (left: children, right: adults). Inset brain depicts the ROI. (B) mPFC engagement shown as in (A). Asterisks/tildes denote condition-level comparisons and main effects of age group. Larger circles represent group means; points are individual participants; error bars are 95% confidence intervals around the group mean. *~ p<0.1, * p<0.05*

demonstrating precise memory for studied photographs. This precision also differed between age groups ($F=17.66$, $p=6.69 \times 10^{-5}$, $\eta^2_G=0.18$), with adults showing greater memory precision than children (no age group differences were seen in response bias or criterion; both $p>0.45$). Among children, age was positively correlated with memory discrimination ($\beta=0.10$, $SE=0.05$, $t=2.01$, $p=0.05$, Figure 1C). Therefore, there were developmental gains in memory precision both between our adult versus child groups and among just the children, importantly emphasizing how memory precision rapidly shifts in our selected 7–9-year-old age range.

aHPC and mPFC Engagement Differences at Encoding

In light of the age group differences observed at the behavioural level, we next asked how hippocampal subregions and mPFC separately encourage subsequent memory success (remembered versus forgotten) and quality (precise versus imprecise) in children versus adults. We expected age-related differences specifically in how aHPC and mPFC encourage imprecise memories, in contrast to the more developmentally consistent role of pHPC in precise memory. Engagement did not vary by subsequent memory success in pHPC (all $p>0.39$) or mPFC (all $p>0.12$), suggesting these regions alone were not related to later remembering. Instead, mPFC was more engaged in children versus adults across the entire task ($F=5.89$, $p=0.02$, $\eta^2_G=0.05$). In contrast, aHPC engagement was related to memory success across age groups, showing marginally greater engagement for subsequently remembered versus forgotten trials ($F=3.36$, $p=0.07$, $\eta^2_G=0.2$), but this was irrespective of memory quality ($p>0.20$). Therefore, contrary to our expectations, none of the ROIs considered in isolation were associated with subsequent memory quality. Rather, both age groups used aHPC similarly to form memories. Moreover, developmental differences were observed in mPFC engagement but irrespective of memory quality, as children engaged mPFC more than adults overall during encoding.

Age Group Differences in How pHPC and mPFC Jointly Support Memory Quality

To explore how hippocampal subregions and mPFC together influence memory quality, we next asked how the engagement of these regions may be associated with one another during subsequent memory success and precise/imprecise memories. We considered both positive and negative associations. A positive association—e.g., when engagement was high in both regions—was reflective of a cooperative relationship between the regions during the particular memory condition. In contrast, a negative association—high engagement in one region and low engagement in the other—was reflective of a competitive trade-off between these regions during the particular memory condition. The relationship between aHPC and mPFC did not vary by memory success or age group (all $p>0.10$), but was reliably positive across age groups ($\beta=0.38$, $SE=0.07$, $t=5.04$, $p=1.26 \times 10^{-6}$)—such that high engagement of aHPC was associated with high engagement of mPFC across participants. By contrast, the relationship between pHPC and mPFC did marginally vary by subsequent memory success across age groups ($\beta=-0.30$, $SE=0.18$, $t=1.66$, $p=0.09$; no effects with age group: all $p>0.27$): There was a reliable (positive) relationship between the two regions during subsequently forgotten ($\beta=0.28$, $SE=0.10$, $t=2.70$, $p=0.01$) but not remembered ($p=0.24$) trials, reflecting that when forming memories that were later forgotten, participants with high pHPC engagement also had high mPFC engagement.

Because the association between pHPC and mPFC varied by subsequent memory status, we next examined whether it also varied by memory quality—i.e., during precise versus imprecise memory formation—and age group. Indeed, it did (interaction: $\beta=-1.10$, $SE=0.27$, $t=-4.08$, $p=7.07 \times 10^{-5}$; Figure 3), with this effect driven by age group differences in this relationship during both precise ($\beta=0.69$, $SE=0.16$, $t=4.23$, $p=6.09 \times 10^{-5}$) and imprecise (trend; $\beta=-0.41$, $SE=0.21$, $t=-1.98$, $p=0.05$) memory formation. The relationship between these regions during precise memory formation was negative in children and positive in adults, suggesting these regions served opposing roles among children but more complementary ones among adults. In contrast, the relationship between these regions during imprecise memory formation was only present in children ($\beta=0.47$, $SE=0.11$, $t=4.20$, $p<0.001$; adults: $p=0.69$) and was positive, meaning that children who showed high engagement of pHPC also

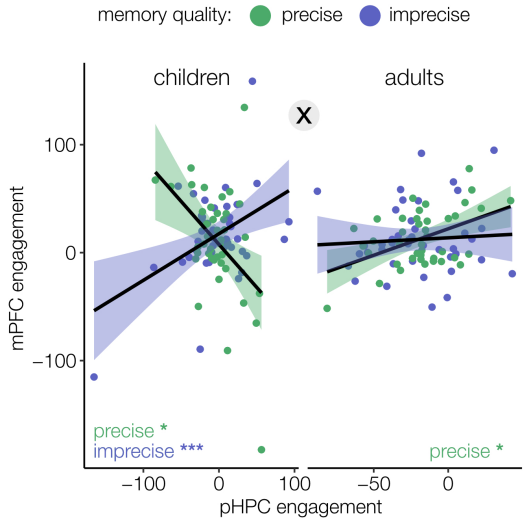

Figure 3. The relationship between pHPC and mPFC engagement during precise versus imprecise memory formation. Across-participants correlation of mPFC engagement (univariate activation; y-axis) and pHPC engagement (univariate activation; x-axis) as a function of subsequent memory quality (green: precise; dark slate blue: precise) and age group (left: children, right: adults). Tensor denotes reliable three-way interaction of the pHPC-mPFC association with subsequent memory quality and age group. Asterisks denote significant model slopes. Points are individual participants and the band around the line represents the standard error. * *p<0.05,* *** *p<0.001*

showed high engagement of mPFC during imprecise memory formation. These results suggest there is a functional flip in how pHPC and mPFC mechanisms jointly encourage memory quality. Precision is initially encouraged by competitive trade-offs in pHPC and mPFC function during childhood, before the emergence of a cooperative relationship in adulthood, where high engagement in both regions yield precision. Imprecision by contrast is uniquely associated with a cooperative relationship between pHPC and mPFC mechanisms only in childhood.

Discussion

We characterized how hippocampal subregions and mPFC together support memory precision in children versus adults. At the behavioural level, we found developmental improvements in this precision between 7-9 year-old children versus adults (consistent with past work; Rollins et al., 2023; Rollins & Cloude, 2018) and even among just the children. At the neural level, different mechanisms encouraged subsequent memory and its quality in each age group. Differences in mPFC and aHPC engagement were observed at encoding—mPFC was overall more engaged in children than adults across encoding, while aHPC engagement instead supported subsequent memory success across age groups. The relationship between hippocampal subregion and mPFC engagement showed a functional flip in how pHPC and mPFC together yield precision: Trade-offs in pHPC and mPFC engagement supported precise memories in childhood in contrast to the cooperative (positive) association between these regions in adulthood. The emergence of adult-like memory precision may therefore rely on a transformation in the relationship between pHPC and mPFC functionality.

Children engaged mPFC more than adults, irrespective of the subsequent memory. As part of the default mode network, this region shows deactivation during many cognitive tasks (Raichle et al., 2001; Shulman et al., 1997). The age group difference in mPFC engagement may therefore reflect adults disengaging the default mode network more than children (Chai et al., 2014), potentially because mPFC undergoes functional refinement beyond childhood (Barber et al., 2013; Chai et al., 2014; Fair et al., 2007; Thomason et al., 2008). Relatedly, mPFC default mode network connections show the most change (Fan et al., 2021) between 7-9 year-olds versus adults (Supekar et al., 2010).

Across age groups, aHPC was sensitive to subsequent memory success but not quality. While aHPC engagement has been linked with successful remembering (Grady, 2020; Kim, 2013), pHPC is more often associated with this effect over development (Poppenk & Moscovitch, 2011; Selmeczy et al., 2019). Here, aHPC engagement might reflect participants' allocation of attentional resources (Mack et al., 2016) in response to our instruction to study the photographs, which would be enhanced for later remembered photographs. One limitation of this investigation is that we did not characterize how participants' attention influences memory precision, and future investigations that measure individual differences in selective attention and their influence on memory precision will be necessary to test this possibility.

Complementing previous work that has shown associations between mPFC and aHPC during memory-related paradigms (Frank et al., 2019; McCormick et al., 2015; Poppenk et al., 2013), here we observed an mPFC-pHPC association related to subsequent remembering and memory quality. The association between mPFC and pHPC may stem from participants being encouraged to store perceptual details of visual experiences. Consistent with this idea, the posterior-medial system, which includes medial temporal cortex and default mode network regions (Ranganath & Ritchey, 2012), stores the spatial aspects of memories (e.g. places) in conjunction with pHPC (Morton et al., 2021) to encourage recollection in adults. Here, details of the scene photographs processed by the posterior-medial system may recruit similar neural profiles in adults' pHPC and default mode network regions in order to store precise memories. Future investigations with these data will assess how broader neocortical systems interact with hippocampus to encourage memory quality.

The relationship between mPFC and pHPC engagement during precise memory formation flipped between age groups: children showed a negative relationship between these regions while adults showed a positive relationship. The negative association observed in children may reflect that mPFC prioritizes generalities across experiences (Bowman & Zeithamova, 2018; Morrissey et al., 2017) at the expense of the event-specific details prioritized by pHPC (Robin & Moscovitch, 2017; Sheldon & Levine, 2016). Trade-offs between these mechanisms are broadly consistent with developmental frameworks that propose generalities are initially prioritized to bolster the later development of mechanisms that store specifics, instead of these mechanisms working together (Keresztes et al., 2018). The shift to a cooperative relationship in adulthood may reflect that the extraction of generalities and event-specific features work in tandem (McClelland et al., 1995, 2020; Norman & O'Reilly, 2003) to encourage memory in the mature brain.

Children's imprecise memory formation was associated with a positive relationship between pHPC and mPFC engagement, mirroring the one observed in adults during precise memory formation. Children's premature adoption of this mechanism may therefore hinder their memory precision, as it instead encourages errors to highly similar experiences. Potentially, the coarser posterior hippocampal memories children form in comparison to adults (Callaghan et al., 2021) may not store events with enough detail to encourage precision when engaged to a similar extent as mPFC.

Together, these findings suggest that memory quality emerges through a functional flip in the association between pHPC and mPFC, from trade-offs in their engagement within childhood to a cooperative relationship in adulthood. More broadly, this may suggest that children and adults rely on different cognitive strategies when learning memorization-based curricula, highlighting the need to develop pedagogical approaches tailored to each age group.

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