Memory Overlap Enhances Shared Feature Recognition but Hinders Specific Memory in Adolescents and Adults

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Abstract

Over time we accumulate memories for many related experiences. However, it remains poorly understood how this relatedness, or overlap, among learned information shapes how we remember shared and unique features. The current study investigated this question and further asked whether effects of overlap on memory differ in adolescence compared to adulthood, given evidence that memory specificity continues to be refined beyond childhood. We had adolescents (12-13 years old) and adults learn pairs of objects that overlapped with one another to different degrees and then tested their memory for both overlapping and pair-unique features. Across both age groups, we found that greater overlap boosted memory for the overlapping feature but also led to worse memory for unique features. Further, adolescents were more detrimentally affected by high overlap than adults when recalling specific pairs. Our results suggest there may be a trade-off between memory for shared and unique features of overlapping materials and that adolescents experience a greater cost to this trade-off. More generally, we find that the connections among learned information play an important role in how it is remembered.

Keywords: associative memory; memory specificity; memory overlap; interference; adolescence

Introduction

As we build a network of interconnected memories over a lifetime, it is important to recall both distinct events as well as commonalities across experiences. For example, in some situations it might be helpful to recall that a particular friend of yours has a pet Border Collie with a white spot while in other scenarios you may need to remember that you have multiple friends with pet dogs. The adult memory system is indeed set up to support the ability to recall specifics as well as shared aspects of related memories in this way (Kumaran & McClelland, 2012; McClelland, McNaughton, & O'Reilly, 1995; Schapiro et al., 2017). However, there has been limited exploration into how these forms of memory are influenced by the degree of similarity, or overlap, among related experiences as well as how this relationship may differ across development.

There is some evidence to suggest that greater similarity among learned information leads to strong gist memory at the cost of detailed memory in adults (Konkle et al., 2010; Wing et al., 2020). For example, Konkle et al. (2010) found that greater conceptual similarity among sets of related objects led to worse specific memory for individual items, indicated by a reduced ability to discriminate between studied and similar items. In addition to detrimental effects on specific memory, greater semantic congruency (van Kesteren et al., 2020) and visual overlap (Molitor et al., 2021) among learned associations have been shown to enhance connections among those associations in memory, as measured through inference-making. Based on this work, we might predict that greater overlap results in memory representations that emphasize shared features, potentially at the expense of unique details. However, there is also evidence that when adults repeatedly study and recall related events, overlapping representations can be pushed apart ("differentiated"), thereby accentuating unique features and reducing interference (Chanales et al., 2021; Favila, Chanales, & Kuhl, 2016; Wing et al., 2020). Consequently, while greater overlap may initially promote memory for shared features at the cost of specifics, adults may be able to minimize its negative effects through the process of learning.

Adolescents may experience a relatively greater cost of overlap on specific memory than adults. A large body of work has documented dramatic improvements in specific memory through early to mid-childhood (Brainerd & Reyna, 2005; Ghetti et al., 2010), however, less is known about its trajectory through adolescence. There is some evidence that memory does continue to be refined beyond mid-childhood when there is particularly high demand for specificity (Ngo, Newcombe, & Olson, 2018; Rollins & Cloude, 2018). Some neuroimaging work also suggests that adolescents may have less access to neural mechanisms that allow for the selective retrieval of target information among competing memories (Sprondel, Kipp, & Mecklinger, 2012, 2013), potentially leaving them more prone to memory interference at retrieval. However, more work is needed to better understand memory specificity at this later stage of development. Here, we hypothesized that adolescents would be able to distinguish among moderately overlapping memories commensurate to adults, given early improvements in specific memory, but would have greater difficulty when a higher level of specificity and interference resolution was required.

It is also unclear how overlap influences memory for shared features in adolescence. The ability to rapidly connect related experiences in memory has a prolonged development (Horn, Bayen, & Michalkiewicz, 2021; Schlichting et al., 2022; Schlichting et al., 2017; Shing et al., 2019), which could leave adolescents with less access to representations that emphasize overlapping features. This prolonged

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maturation tracks with the development of brain regions and circuits (Gogtay et al., 2004; Gogtay et al., 2006; Ofen et al., 2012; Sowell et al., 2003) that are critical for integrating related memories in adults, including the ventromedial prefrontal cortex (PFC) (Spalding et al., 2018) and hippocampus-medial PFC connections (Zeithamova, Dominick, & Preston, 2012). Given the relatively earlier emergence of specific memory, young adolescents may tend to retrieve specific rather than interconnected representations of overlapping memories. We thus hypothesized that adolescents would not show the same benefits of overlap for recalling shared features as adults.

In the current study, we aimed to characterize how overlap among learned information shapes memory for shared and unique features in adolescents and adults. We had 12–13-year-olds and adults learn pairs of objects which overlapped with others through inclusion of an object from the same category, e.g. multiple pairs each containing different apples. We chose items with either high (apples, shells) or low (leaves, rocks) intra-category similarity along perceptual and conceptual dimensions, yielding high or low overlap among the corresponding pairs. We then tested memory for shared (i.e., category) as well as unique (specific item) features of overlapping pairs. We predicted that adults but not adolescents would spontaneously connect related pairs and thus benefit from greater overlap when retrieving shared features. In contrast, we hypothesized that greater overlap would lead to worse memory for pair-specific features across age groups. We additionally expected adolescents to show particularly poor specific memory for highly overlapping associations due to greater demands on their developing fine-grained memory and interference resolution abilities.

Methods

Participants

Data from 39 adolescents (17 girls, 20 boys, 2 nonbinary, 12-13 years old, *M*=12.4, *SD*=0.5) and 36 young adults (19 women, 17 men, 25-35 years old, *M*=29.4, *SD*=3.2) are presented here. Participants were excluded from recruitment according to preregistered criteria (https://osf.io/6tehk) created for the purposes of magnetic resonance imaging (MRI) analyses (results not reported here). All participants provided informed consent/assent prior to participating and were compensated with $20/hour (CAD) and a bonus of up to $3 depending on performance. Permission was obtained from the parent or guardian of all adolescents. All procedures were approved by the ethics committee at our university.

Stimuli

To establish overlapping memories, participants learned 24 pairs of object images which each included a natural object from one of four categories (apple, shell, leaf, rock) and an unrelated artifact (e.g., broom; Fig. 1a). We manipulated the degree of overlap among pairs by selecting natural objects (6 per category) from two categories with high intra-category similarity on both perceptual and conceptual dimensions (apple, shell) and two with low similarity (leaf, rock), from a stimulus set with previously collected similarity ratings (Konkle et al., 2010). Artifacts were images of distinct everyday objects chosen to be commonly nameable by the age of 12 (Kuperman, Stadthagen-Gonzalez, & Brysbaert, 2012) and unrelated to the natural objects. Artifacts were paired semi-randomly to natural objects for each participant with the constraint that each artifact-natural category pairing occurred equally often across participants.

Procedure

Training To establish memory for the overlapping pairs, participants completed eight cycles of alternating study and test (Fig. 1b). During study, each pair was presented for 3.5 seconds (0.5s inter-trial interval) and participants were instructed to create a story linking the items together, which they were not required to report aloud. After study, participants were tested on their memory and given feedback to promote learning. For each training test trial, they selected which of two studied natural objects was paired with a given artifact. To prevent initial pair learning from being prohibitively difficult, questions initially followed a "neutral" structure (cycles 1-4) for which the options belonged to different categories (e.g., apple 1 or shell 1). These questions could be answered by remembering either the category or specific item. The second half of training ensured that participants remembered which particular exemplar was paired with each artifact by using "specific" test questions for which they selected between natural objects from the same category (e.g., apple 1 or 2). Participants had as long as needed to respond via keypress, after which they received feedback (1s) indicating the correct choice, followed by a fixation cross (0.5s). At the beginning of the task, participants made aware through the instructions as well as a practice session that they would sometimes need to distinguish between items of the same "kind", i.e., category.

Pairs were presented in semi-random order within study and test, with the constraint that no more than two pairs associated with the same category were presented in a row. The position of the objects on screen (left or right) was randomized across trials. To prevent bias in the distinctions participants were trained to make among pairs, the number of times each item and category of item was used as a lure was balanced across testing cycles.

Post-Training Memory Task To assess how overlap influenced memory for shared and unique features, we had participants complete a memory test without feedback after they finished training. The questions followed three different structures: neutral, specific, or general (Fig. 1c). Specific and neutral questions were constructed in the same manner as training. Specific questions tapped memory for unique features of overlapping associations because participants had to remember which particular exemplar distinct from other similar items was paired with an artifact. Neutral questions could be answered by remembering either the general category or specific item. "General" questions assessed

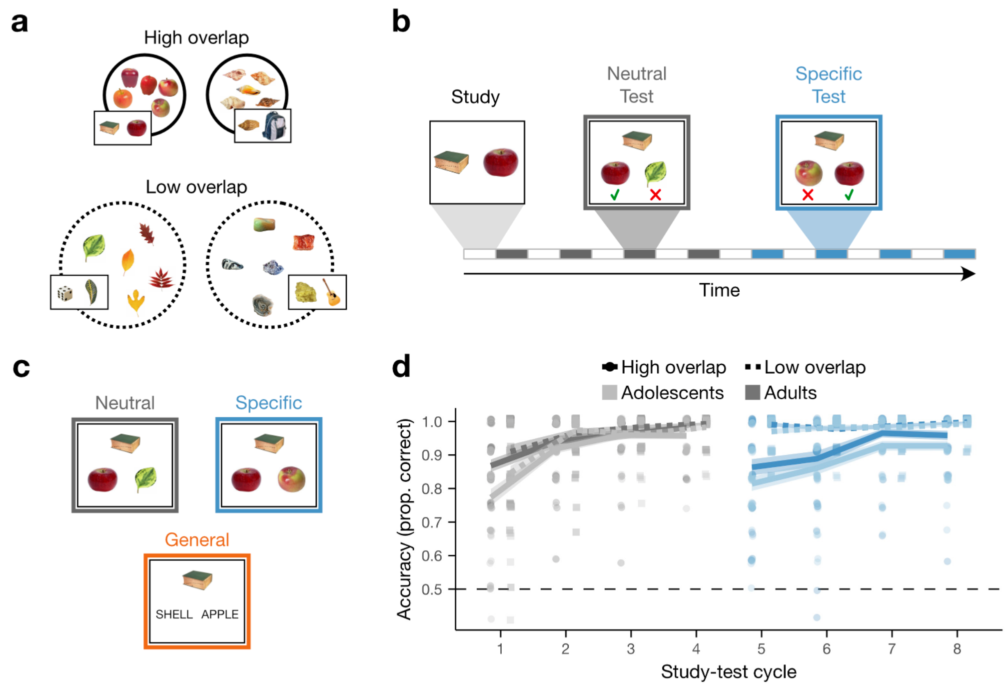

Figure 1: Experimental procedure (a-c) and training performance (d). **a.** Natural objects from categories with high or low overlap were paired with unique artifacts. **b.** Training included alternating cycles of study and test with feedback, beginning with neutral and then specific test questions. **c.** Post-training memory task question types. **d.** Training test accuracy across cycles for high (solid line, circle point) and low (dashed line, square point) overlap pairs. Points indicate each individual participant's performance. Lines indicate mean accuracy. Ribbons indicate standard error.

memory for the feature shared amongst overlapping associations. On these questions, participants were asked to remember the *category* paired with a given artifact by selecting between two written labels (e.g., was the book paired with an apple or shell?). The correct answer for all artifacts paired with apples would be "apple", i.e., the shared feature among the overlapping associations. Unlike neutral questions, general questions could not be answered by recognizing the item's unique features, given the options were presented in text format, and thus more cleanly assessed memory for the category. Trials were self-paced as in training. To prevent further learning, there was no feedback and instead a fixation cross appeared (0.5s) immediately after each response.

All 24 pairs were tested once per block for three blocks. Across blocks, each pair was tested with each question type and the order in which it was tested with a neutral, specific, and general question was balanced across pairs. Within a block, question type was semi-randomly ordered such that the transitions between questions (e.g., neutral–specific, neutral–general) were roughly balanced. After this task, participants completed additional memory tasks while functional MRI data were collected (not discussed here).

Perceptual Discrimination Task To confirm that the effects of overlap on memory could not be explained by how well participants were able to visually distinguish category exemplars, participants completed a perceptual discrimination task at the end of the experimental session. They were asked to report whether sequentially presented images were the same item or different. On some trials these images were the exact same and on others they were different items, either from the same or different categories. For each trial, the target object was presented for 1 second followed by a category-specific visual mask for 0.5 seconds. We created the scrambled mask images by randomly sampling object images from the target category (e.g., apples). After the mask, a probe item was presented (1s) and participants indicated via keypress whether it was the same (identical) or different from the target. Trials were self-paced to encourage high accuracy. If a response was not made within 1 second, the probe was replaced with a question mark until a response was made. A fixation cross appeared for 1 second between trials.

Each object was tested against itself (same-item trials) once and against every other object in the same category (within-category "different" trials) once. Additionally, each object was tested against an object from a different category once (across-category "different" trials). These trial types were semi-randomly intermixed with the constraint that no two targets from the same category were used in sequence. Additionally, the 96 trials were split into three blocks such that for each block there were two same-item trials per category (8 total), five within-category trials per category (20 total), and four across-category trials.

Analysis

To first establish whether degree of overlap influenced pair learning, we compared accuracy for high and low overlap pairs across training test cycles. To do this, we ran separate generalized linear mixed-effects models in R (lme4::glmer v1.1-25, logit link; Bates et al., 2015) for neutral (cycles 1-4) and specific (cycles 5-8) training phases predicting trial-wise accuracy (correct or incorrect) as a function of cycle, overlap (high or low), age group (adolescent or adult), and their interactions. We also tested whether including a quadratic term for cycle improved model fits. Additionally, we asked whether the transition from neutral to specific testing differentially impacted high and low overlap pairs by running a model predicting accuracy on the last cycle of neutral and first of specific training as a function of question (neutral or specific), overlap, and age group. All models included participant-specific intercepts and slopes for within-participant factors (e.g., overlap, cycle). We expected that high and low overlap pairs would be learned with similar ease when participants were not required to remember the specific exemplar paired with an artifact but that differences would manifest once memory was tested at a more specific level.

To address how overlap influenced memory for shared and unique features, we ran similar generalized linear mixed-effects models predicting trial-wise accuracy on the memory task as a function of overlap, age group, question type, and their interactions. We again included participant-specific intercepts and slopes. We also ran parallel linear mixed-effects models (lme4::lmer) to predict log-transformed response times on correct trials, excluding performance on the first trial of the task. We tested the significance of the predictors in each model using a Wald chisquare test (Type II if no interactions were significant, Type III otherwise; car::Anova v3.0-10; Fox & Weisberg, 2019). Follow-up pairwise comparisons were conducted using model estimated marginal means (emmeans::emmeans v1.6.0; Lenth, 2021).

Finally, we conducted a control analysis to ensure that adults and adolescents were able to perceptually discriminate exemplars from high and low overlap categories with similar success. We ran generalized linear mixed-effects models (logit link) predicting responses on the perceptual discrimination task, coded as 1 for "different" and 0 for "same", from trial type (within-category or same-item), age group, overlap, and their interactions. We excluded across-category trials which were irrelevant to this analysis. Random slopes and intercepts for participant were included in each model. One adult participant was excluded from perceptual discrimination task analyses because they misunderstood the instructions and responded "same" for within-category as well as same-item comparisons.

Results

Pair Learning Influenced by Overlap

We first established whether learning across training cycles differed according to degree of overlap among pairs (Fig. 1d). For neutral training questions (cycles 1-4), we found that participants were more likely to remember the pairs correctly as a quadratic function of cycle ($\chi^2(2) = 198.47$, $p < .001$; model comparison: $\chi^2(15) = 30.08$, $p = .01$) and adults performed better than adolescents overall ($\chi^2(1) = 11.15$, $p < .001$). Somewhat contrary to our expectations, overlap also influenced performance ($\chi^2(1) = 46.54$, $p < .001$) such that participants were less accurate on high compared to low overlap pairs even though it was not yet necessary to distinguish between similar exemplars. There were no two- or three-way interactions among overlap, cycle, and age group (all $\chi^2 < 3.8$, $p > .1$).

The same pattern of effects was present for the last half of training on specific questions (cycles 5-8). The probability of making the correct choice increased linearly over cycles ($\chi^2(1) = 89.50$, $p < .001$; model comparison: $\chi^2(15) = 8.90$, $p = .88$), was greater for adults than adolescents ($\chi^2(1) = 6.11$, $p = .01$), and worse for high than low overlap pairs ($\chi^2(1) = 126.75$, $p < .001$; no two- or three-way interactions among factors: all $\chi^2(1) < 1.4$, $p > .2$). Our results overall suggest that manipulating overlap did result in greater interference among high compared to low overlap pairs, which manifested early in learning and persisted across training.

We predicted a difference across the two halves of training in that specific questions would require greater memory specificity than established during neutral training. Indeed, we found a significant drop in accuracy when participants transitioned from neutral (cycle 5) to specific (cycle 6) training tests ($\chi^2(1) = 82.82$, $p < .001$; no two- or three-way interactions among factors: all $\chi^2(1) < 2.0$, $p > .1$). When broken down by overlap level, both age groups showed a drop in accuracy for high overlap pairs (adolescent: $z = -6.80$, $p < .001$; adult: $z = -5.89$, $p < .001$) while only adolescents also had a smaller, reliable drop for low overlap pairs (adolescent: $z = -2.47$, $p = .01$; adult: $z = -1.28$, $p = .2$). As intended, specific questions seem to have demanded more fine-grained memory than neutral questions and thus caused a brief decline in accuracy between the training phases.

Opposing Effects of Overlap on Shared and Unique Feature Memory

To address our main question, we tested whether post-training memory for shared features (general questions) and unique features (specific questions) differed according of the degree of overlap among learned associations. On the memory test, adults no longer performed better overall compared to adolescents, nor were there reliable age differences across overlap levels or question types (all $\chi^2 < 0.3$, $p > .8$). Consistent with our predictions, we indeed found that overlap had an effect on memory accuracy which varied according to question type (Fig. 2a; question x overlap: $\chi^2(2) = 11.52$, $p = .003$; question: $\chi^2(2) = 9.11$, $p = .01$; overlap: $\chi^2(1) = 0.0$, $p = 1.0$). Follow up comparisons revealed a striking pattern of opposing effects on general and specific questions. Both adolescents ($z = -2.07$, $p = .04$) and adults ($z = -2.24$, $p = .03$) were more likely to remember the correct category for high compared to low overlap pairs (across age

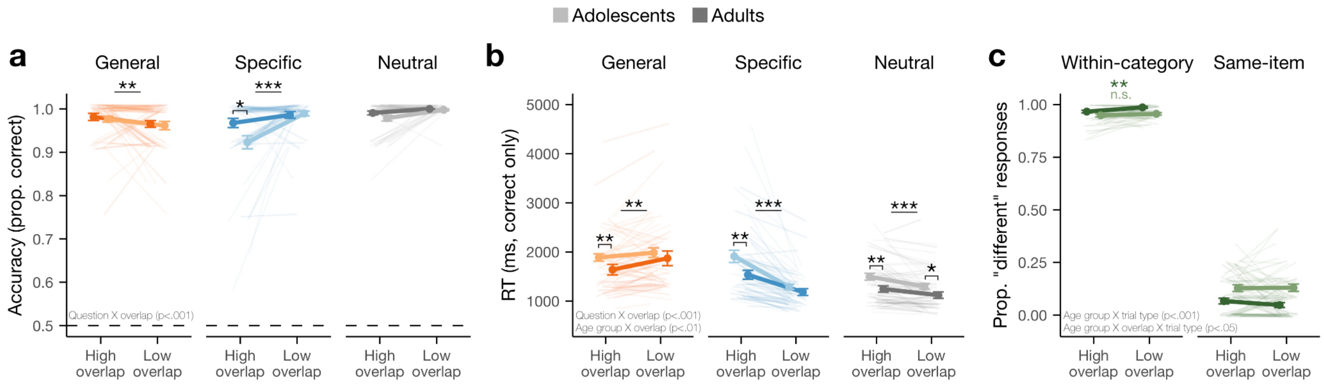

Figure 2: Performance on memory (a-b) and perceptual discrimination (c) tasks by pair overlap. **a.** Memory task accuracy on general, specific, and neutral questions. Dashed line indicates chance performance. **b.** Memory task response times on correct trials. **c.** Proportion of "different" responses on perceptual discrimination task for within-category and same-item comparisons. Lines indicate individual participant (thin) and group mean (thick) performance. Error bars indicate standard error. Significant interactions indicated in bottom left corners. Asterisks indicate significant pairwise comparisons (black: across age groups, darker shade: adults only, lighter: adolescents only): ***p<.001; **p<.01; *p<.05; n.s. p>.05

groups: $z = -3.04$, $p = .002$). This suggests that greater overlap boosted memory for the shared feature, i.e., category, of overlapping pairs and this was true even for young adolescents. In direct contrast, participants were *less* likely to remember the specific exemplar for high compared to low overlap pairs (adolescents: $z = 3.72$, $p < .001$; adults: $z = 2.67$, $p = .008$; across age groups: $z = 4.52$, $p < .001$). Moreover, adolescents performed significantly worse than adults on specific questions selectively for high overlap pairs ($z = 2.51$, $p = .01$) but not low overlap pairs ($z = -0.07$, $p = .9$). There were no such age group differences for the other questions (all $z < 1.4$, $p > .1$). Therefore, in addition to boosting shared feature memory, greater overlap impeded memory for the unique features of related associations, especially for adolescents. These conflicting effects may have offset one another on neutral questions, for which accuracy did not differ significantly by overlap ($z = 0.003$, $p = 1.0$).

Similar effects of overlap on memory were evident in response times. Participants were faster to select the correct category label but slower to select the correct specific exemplar for higher overlap pairs (Fig. 2b; question x overlap: $\chi^2(2) = 61.53$, $p < .001$; question: $\chi^2(2) = 212.94$, $p < .001$; overlap: $\chi^2(1) = 15.06$, $p < .001$). In a distinction from the accuracy pattern, participants were also slower to respond correctly for high compared to low overlap pairs on neutral trials (adults: $z = -3.88$, $p < .001$; adolescents: $z = -5.24$, $p < .001$; across age groups: $z = -6.18$, $p < .001$), suggesting that high overlap produced some interference even at this lower threshold for memory specificity. Additionally, adolescents were slower to respond correctly than adults overall ($\chi^2(1) = 5.94$, $p = .02$; no interactions between age group and overlap, question, or both: $\chi^2 < 1.6$, $p > 0.4$).

Adults but not Adolescents Sensitive to Overlap at Perceptual Discrimination

Finally, we sought to establish whether effects of overlap on memory could be attributed to the perceptual discriminability of category exemplars. To test this, we compared how well participants were able to discriminate exemplars from high and low overlap categories (Fig. 2c). First, we confirmed that participants completed the task correctly: exemplars within the same category were identified as "different" more often than identical items ($\chi^2(1) = 389.72$, $p < .001$; remains significant with excluded adult) by both adults ($z = -23.57$, $p < .001$) and adolescents ($z = -22.56$, $p < .001$). There was also an interaction between trial type and age group ($\chi^2(1) = 23.01$, $p < .001$; age group: $\chi^2(1) = 12.88$, $p < .001$) whereby adults responded more accurately than adolescents for both within-category ($z = -3.60$, $p < .001$) and same-item ($z = 4.09$, $p < .001$) trials.

Critically, we found that overlap did affect performance in a way that differed across both trial type and age group ($\chi^2(1) = 3.96$, $p = .047$). Performance on same-item comparisons did not vary by overlap (all $z < 0.8$, $p > .4$). However, adults were significantly less likely to correctly identify items as different if they were from high compared to low overlap categories ($z = 2.88$, $p = .004$) while adolescents showed no such effect ($z = 0.77$, $p = .44$). Therefore, while adults showed overall better perceptual discrimination than adolescents, they were more sensitive to overlap. This may have contributed to their difficulty discriminating between high overlap pairs on the specific memory tests. In an important contrast, adolescents were not affected by the overlap manipulation at perception, even though their exemplar memory was more impeded for high overlap pairs than adults.

Discussion

In the present study, we investigated how overlap among learned materials influences how adolescents and adults remember shared and unique features. We found that greater overlap enhanced memory for overlapping information. Contrary to our hypotheses, this was true for adolescents as well as adults. In the opposite direction, we found that both age groups performed worse when remembering unique features from highly overlapping associations, suggesting that greater overlap may have also impeded specific memory. As predicted, adolescents showed particularly strong negative effects of overlap on specific memory. However, they showed no such effects of overlap on perceptual discrimination, indicating that their performance on specific memory questions was not because they were less able to tell apart items from higher overlap categories.

In keeping with our predictions, greater overlap produced interference in specific memory. In fact, this interference was evident early in learning. After training, overlap only had detrimental effects on detailed memory accuracy rather than on overall associative memory. These results align with previous work in adults demonstrating that increased similarity among learned materials leads to decreased memory specificity (Chanales et al., 2021; Konkle et al., 2010; Wing et al., 2020), perhaps because related memories interfere with one another at retrieval. Complicating this interpretation, adults were also less able to perceptually discriminate between high compared to low overlap exemplars. However, it is unlikely that the effect of overlap on their specific memory performance was solely due to difficulty visually distinguishing response options; adults also exhibited some interference for high overlap pairs on questions that did not require distinguishing between similar items, as indicated by slower response times on neutral questions. Interestingly, our findings echo work in older adults which links perceptual discrimination abilities to memory specificity (Gellersen et al., 2021). Future work will extend this research to directly test how the specificity with which incoming information is processed at perception may inform how it is later remembered in young adulthood.

In contrast to adults, adolescents were similarly able to perceptually discriminate exemplars from high and low overlap categories but were even more negatively affected by high overlap when remembering unique features. Indeed, this was the only condition in which adolescents performed worse than adults on the memory task. Our results add to emerging evidence that memory precision continues to increase through adolescence (Rollins et al., 2018). Previous work has suggested that such increases in specific memory are linked to the prolonged maturation of the hippocampus (Callaghan et al., 2021; Keresztes et al., 2017; Lee, Ekstrom, & Ghetti, 2014). However, the age differences we observed may also be tied to immature mechanisms for top-down selection among competing memory traces at retrieval (Sprondel et al., 2012, 2013). Future research should tease apart the dual developmental trajectories of representational specificity and retrieval control which likely interact to produce such refinements in detailed memory through adolescence.

In contrast to age differences in specific memory, we found that adolescents benefitted from overlap to a similar degree as adults when retrieving shared features. One explanation for this finding is that both adolescents and adults are more likely to spontaneously link related experiences with greater overlap and thus demonstrate enhanced memory for their common elements. The paradigm we used did not explicitly require participants to connect overlapping associations in memory, so it is remarkable that we see such an effect at all. If anything, task instructions and cycles of specific tests during training likely encouraged participants to distinguish between overlapping associations (Hulbert & Norman, 2015). An intriguing question prompted by the current work is whether adolescents and adults require the same amount of exposure in order to connect overlapping materials in memory and experience boosts in shared feature memory. Though adolescents here showed a similar pattern to adults after many opportunities to learn, future work may ask whether adolescents require greater exposure to overlapping materials than adults to extract generalities.

Though not shown at the level of individual associations, our results point to a trade-off between memory for shared and unique features. One possible explanation, in line with integrative encoding theories (Shohamy & Wagner, 2008; Zeithamova, Schlichting, & Preston, 2012), is that overlap between a current and past experience during learning triggers the formation of integrated representations that link memories through their shared elements (Eichenbaum, 2000). This type of representation could lead to enhanced memory for shared features but reduced memory for idiosyncrasies (Carpenter & Schacter, 2017; Varga, Gaugler, & Talarico, 2019). Moreover, the likelihood of forming integrated representations may increase with greater overlap among experiences (Leutgeb et al., 2004; Vazdarjanova & Guzowski, 2004), perhaps non-monotonically (Ritvo, Turk-Browne, & Norman, 2019). The current study implies that adolescents experience an even larger trade-off between shared and unique feature memory when there is greater overlap, which may indicate that they are less able to preserve experience-unique details when conditions promote memory integration. Such an emphasis on extracting generalities rather than remembering specifics may in fact be adaptive function supporting crucial knowledge building at this stage of development (Keresztes et al., 2018). Future work is needed to directly test how degree of overlap influences the types of neural representations formed and retrieved for related memories across development. Moreover, future work may investigate whether overlap influences memory differently depending on the nature (e.g., perceptual or conceptual) of shared and unique features.

Flexible recall of both the commonalities and unique features of related experiences is critical for making use of one's past to inform behaviour (Buckner, 2010; Eichenbaum, 1999; McClelland et al., 1995). Here, we have shown that greater overlap among related experiences enhances memory for shared features but comes at the cost of specific memory. Moreover, this relationship is present in early adolescence, indicating that 12–13-year-olds organize related memories in a similar manner to adults. However, we find that memory specificity continues to be refined through adolescence, especially when elevated precision and distinction from similar memories is necessary. Our results emphasize the key role that overlap among learned information plays in how humans across development remember.

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