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Characterizing age-related changes in remembering the past and imagining the future

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Abstract

When remembering past events or imagining possible future events, older adults generate fewer episodic details than do younger adults. These results support the constructive episodic simulation hypothesis: deficits in retrieving episodic details underlie changes during memory and imagination. To examine the extent of this age-related reduction in specificity, we compared performance on memory and imagination tasks to a picture description task that does not require episodic memory. In two experiments, older adults exhibited comparable specificity reductions across all conditions. These findings emphasize the need to consider age-related changes in imagination and memory in a broader theoretical context.

Keywords

Autobiographical Memory; Aging; Imagining; Autobiographical Interview; Picture Description

During the past several years, converging evidence from cognitive psychology, neuropsychology, and neuroimaging has documented that episodic memory a neurocognitive system that supports recollection of personal experiences (Tulving, 2002) – also plays an important role in imagining or simulating future experiences (for recent reviews, see Schacter, Addis, & Buckner, 2008; Suddendorf & Corballis, 2007; Szpunar, in press). Addis, Wong, and Schacter (2008) extended this line of research to cognitive aging. Addis et al. (2008) used an adapted version of the Autobiographical Interview, a protocol developed by Levine et al. (2002) that segments individuals' descriptions of experiences into episodic or "internal" details (e.g., who, what, when, and where details) and "external" details (e.g., semantic information, other external events, repetitions). Levine et al. (2002) found that older adults produced fewer internal and more external details than did younger adults when recalling past autobiographical events.

In the Addis et al. (2008) experiment, older adults remembered past experiences or imagined future events in response to word cues, providing as much detail as possible for three minutes per episode. Replicating Levine et al. (2002), older adults provided fewer internal

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(episodic) details and more external (semantic) details than did younger adults when remembering the past. Importantly, Addis et al. (2008) documented a parallel aging deficit for imagining future events: older adults provided fewer internal details and more external details than did younger adults (see also, Addis, Musicaro, Pan, and Schacter, in press). Addis et al. (2008) interpreted these results as support for the *constructive episodic simulation hypothesis* (Schacter & Addis, 2007), which maintains that both remembering the past and imagining the future are supported by a constructive episodic memory system that is capable of flexibly recombining elements of prior experiences into simulations of future events. However, because the Autobiographical Interview involves producing an extended narrative, differences between young and old adults in memory and imagination on the Autobiographical Interview could also reflect age deficits in non-episodic mechanisms.

To address this issue, we report two experiments that include a condition absent from previous studies using the Autobiographical Interview. Older and younger adults were instructed to describe a complex picture of a natural scene in as much detail as possible. The key question is whether the pattern previously observed for memory and imagination – reduced internal and increased external for older adults relative to young-also extends to a picture description task that does not require episodic memory.

Experiment 1

Experiment 1 examines imagination for personal events relative to description of events presented in a picture - a condition in which access to episodic memory is not required for task performance.

Method

Participants—Sixteen healthy younger adults (age, 18–35 years, *M* = 24.00 years, 8 female) and sixteen older adults (age, 65–88 years *M* = 74.21 years, 10 female) with no history of neurological impairments participated in this study. All subjects had normal or corrected to normal vision. Older adults also performed normally on the Mini-Mental State Examination (*M* = 28.75, *SD* =1.44). Older adults had on average completed more years of education than had younger adults, but the difference did not attain statistical significance (Older: *M*=16.25 years, *SD*=3.38; Younger: M=14.56, *SD*=1.89; *p*=.09.

Stimuli and Design—The study stimuli consisted of 12 colored photographs that depicted people engaged in a particular activity or set of activities. Successful generation of events was encouraged by selecting activities that both age groups could relate to; for example, lounging on a beach, enjoying a picnic in a park, or dance reception. For the duration of each trial, a picture (size, 964 × 734 pixels) was displayed on a computer with the relevant task instructions (Describe or Imagine). Trials were blocked by condition to reduce cognitive load and facilitate older adults' comprehension of instructions. Presentation order of conditions was counterbalanced across subjects. Each condition included 2 practice trials and 4 experimental trials, consistent with our previous work with older adults using the Autobiographical Interview (Addis et al., 2008, in press).

Autobiographical Interview—For each trial, participants completed an adapted version of Autobiographical Interview: they either described details about a picture or imagined an event using the picture as the general setting. General prompts were given when necessary to clarify instructions or solicit further details. For description trials, participants were required to describe the different people, objects, and environment in the picture and their relationship to one another (e.g. What are the people doing? What do they look like? Where are they?). Participants were instructed to report only what was literally depicted in the picture without embellishing. For imagination trials, participants imagined events that could

possibly occur in the next few years with the picture as the general setting. Imagined experiences did not need to strictly involve the elements presented in the picture, so that participants would successfully generate an event. Events were restricted to the future few years, because the advanced age of some older adults meant they could not generate events far into the future. Participants were instructed to experience events from a field perspective (through their own eyes) rather than from an observer perspective (from an external vantage point). Events generated for imagination trials were required to be specific in time and place, lasting several minutes to hours, but not exceeding a day. In all tasks, participants recounted as many details as possible for 3 minutes per picture.

Scoring—Consistent with previous studies of memory and imagination, we adapted the conventional Autobiographical Interview protocol developed by Levine et al. (2002) to systematically parse details in all tasks. Coders were assessed for interrater reliability on the basis of an intraclass correlation analysis for scores of 20 responses collected from previous studies, two-way mixed model; standardized Cronbach's $\alpha = .92$ for internal Autobiographical Interview scores and .85 for external scores). Importantly, the principal coder was blind to the hypotheses of this study so as to avoid a potential confirmation bias. For imagination trials, the central event was identified; if more than one event was mentioned, the event discussed in more detail was designated the central event. For the description trials, any perceptual detail that depicted elements in the picture as it was presented was considered part of the central event. Then the transcription was segmented into distinct details (e.g. unique chunks of information), and these details were categorized as internal (episodic detail relevant to the central event) or external (semantic details, repetitions, and irrelevant episodic details). While verbatim descriptions of items taken directly from the picture were scored as internal details for description trials, they were scored as external details for imagination trials, so that only actually imagined events counted toward internal details on imagination trials. Inferences about the picture (e.g. speculating about the temperature, providing explanations for peoples' actions) were scored as external details for description trials. Coders referenced the appropriate pictures to classify details internal or external.

Results

We assessed age-related differences in picture description and imagination by conducting a mixed factorial 2 (Age: Young, Old) × 2 (Task: Describe, Imagine) × 2 (Detail: Internal, External) ANOVA. We found a significant main effect of Age, with older adults producing overall fewer details than did younger adults, $F(1,30) = 17.31$, $p < .01$, $\eta^2 = .36$, as well as a significant main effect for detail, indicating more internal than external details were provided across age and task $F(1,30) = 130.47$, $p < .01$, $\eta^2 = .81$. There was significant main effect of Task, reflecting more detail generated in the picture description condition than the imagination condition, $F(1,30) = 34.82$, $p < .01$, $\eta^2 = .537$. These main effects were qualified by a significant Age × Detail interaction: older adults generated fewer internal details and more external details, $F(1,30) = 24.48$, $p < .01$, $\eta^2 = .45$, compared with young adults (Figure 1A). No Age × Task ($F(1,30) = .45$, $p = .51$, $\eta^2 = .015$) or Age × Task × Detail ($F(1,30) = .01$, $p = .97$, $\eta^2 = .00$) interactions were observed. The finding that older adults produced fewer internal details than did young adults indicated an age-related deficit in episodic specificity consistent with previous findings.

To further evaluate the contribution of aging to reduced episodic specificity of imagination performance, we conducted a hierarchical multiple regression analysis with episodic (internal) detail of imagined events as the dependent variable and picture description performance (internal details) and age as predictors. After entering picture description performance into the model, age-related performance in the imagination condition was

loaded. The analysis revealed that number of internal details provided in the picture description condition was a significant predictor of number of internal details provided in the imagination condition, $R^2 = .455$, $F(1,30) = 25.01$, $p < .001$. When age was added in the second step, it predicted a significant but relatively small amount of variance in number of details provided in the imagination condition, R^2 change = .13, $F(1,30) = 9.09$, $p < .01$. The hierarchical multiple regression thus showed that, while relatively weak, there was an age-related deficit in imagination that could not be attributed to general descriptive ability.

Experiment 2

Experiment 1 yielded three key results. First, using pictorial cues in the imagination condition, we replicated previous findings in studies using word cues that older adults produce fewer internal and more external details than younger adults (Addis et al., 2008, in press). Second, we extended this pattern to a picture description task that does not require episodic memory. Third, we found that while picture description performance was a significant predictor of imagination performance, age accounted for some variance in imagination performance, above and beyond picture description performance. In Experiment 2, we attempted to determine whether a) the key results from Experiment 1 could be replicated, and b) they extend to an autobiographical memory condition in addition to picture description and imagination conditions. Including an autobiographical memory condition should allow us to observe whether the small age-related deficit in imagination we found would remain after controlling for decline in episodic specificity of general descriptive ability *and* remembering personal experiences.

Method

Participants—Fifteen healthy younger adults (age, 19–35 years, $M = 25.00$ years, 5 female) and fifteen older adults (age, 65–88 years $M = 74.08$ years, 6 female) with no history of neurological impairment participated in this study. All subjects had normal or corrected to normal vision. Older adults also performed normally on the Mini-Mental State Examination ($M = 28.93$, $SD = 3.21$). Older and younger adults completed a similar number of years of education, (Older: M=16.4 years, SD=32.35; Younger: M=15.47, SD=1.85; p=.23.

Stimuli, Design, Autobiographical Interview, and Scoring: Six color photographs were added to the stimuli used in Experiment 1, consisting of the same parameters as the original photographs. Procedures for Experiment 2 were the same as in Experiment 1, but with the addition of an autobiographical memory condition. Memory trials involved remembering a personal event that occurred in the last few years (versus the next few years for imagined events) using the picture as a cue to help focus on an event. Participants were instructed to remember events related to the contents of the picture, but events did not need to strictly consist of the exact situation depicted in the picture.

Memories were required to be specific in time and place, lasting several minutes to hours, but not exceeding a day. Participants were instructed to experience events from a field perspective rather than from an observer perspective. Scoring for description and imagination trials was the same as in Experiment 1, and memory trials were scored according to Autobiographical Interview protocol in a similar manner to imagination trials from Experiment 1. As in Experiment 1, each condition included 2 practice trials and 4 experimental trials. Trials were blocked by condition, and presentation order of conditions was counterbalanced across subjects.

Results

We assessed age-related differences in picture description, memory, and imagination by conducting a mixed factorial 2 (Age: Young, Old) × 3 (Task: Describe, Remember, Imagine) 2 (Detail: Internal, External) ANOVA. Once again, we found significant main effects of Age $F(1,28) = 8.44$, $p < .01$, $\eta^2 = .232$, and Detail, $F(1,28) = 124.78$, $p < .01$, $\eta^2 = .817$, qualified by an interaction: compared with younger adults, on the imagination, memory, and picture description tasks, older adults generated fewer internal details and more external details $F(1,28) = 15.01$, $p < .01$, $\eta^2 = .349$ (Figure 1B). There was also a significant main effect for Task, $F(1,28) = 26.05$, $p < .01$, $\eta^2 = .482$. Post hoc Bonferroni corrected pairwise t-test revealed that more details were generated for picture description than memory or imagination, $p < .025$. No Age x Task interaction ($F(1,28) = 1.04$, $p = .36$, $\eta^2 = .04$) or Age × Task × Detail interaction ($F(1,28) = 3.63$, $p = .07$, $\eta^2 = .16$) was found.

To assess the contribution of aging to imagination and memory performance beyond a general ability to describe events, we conducted two hierarchical multiple regression analyses; one with episodic (internal) detail in the imagination condition as the dependent variable and picture description performance (internal details) and age as predictors, the other with episodic (internal) details in the memory condition as the dependent variable and picture description performance (internal details) and age as predictors. Consistent with the first experiment, our analysis revealed that the number of internal details produced in the picture description condition was a significant predictor of internal details produced in the imagination condition, $R^2 = .737$, $F(1,28) = 78.343$, $p < .001$. When age was added in the second step, it significantly (though modestly) improved the model's capacity to account for variance in the imagination condition, R^2 change = .09, $F(1,28) = 14.126$, $p < .001$. Similarly, for the second hierarchical regression model, number of internal details in the picture description condition was also a significant predictor of internal details in the memory condition, $R^2 = .783$, $F(1,28) = 44.317$, $p < .001$. When age was added as a predictor of internal details in the memory condition it significantly –but again only modestly- improved, R^2 change = .123, $F(1,28) = 13.877$, $p < .001$. Of theoretical interest is whether an aging imagination deficit remains above and beyond *both* a difference in descriptive ability *and* deficits in memory. To this end, we conducted a hierarchical regression entering description and then memory performance in separate blocks before adding age. As expected, the number of internal details in the picture description condition was a significant predictor of imagination performance ($R^2 = .783$, $F(1,28) = 78.343$, $p < .001$). Adding number of internal details in the memory condition as a predictor slightly but significantly improved the model (R^2 change = .076, $F(1,28) = 10.916$, $p < .01$) Interestingly, we found a small but significant imagination-specific deficit, R^2 change = .030, $F(1,28) = 4.915$, $p = .036$.

Discussion

The two experiments reported here provide novel information concerning the basis of age-related reductions in the specificity of remembered past events and imagined future events. If age-related deficits in episodic detail of imagining and remembering could be attributed entirely to impairments specific to memory function, we would have expected the age-related impairment in episodic detail for the picture description task to be reduced or non-existent relative to impairment evident for the imagination and memory tasks. Alternatively, if mechanisms other than memory contribute to performance on the memory or imagination tasks, we would expect parallel patterns across all tasks. While we replicated previous findings of age-related reductions in episodic specificity for remembered and imagined events (Addis et al., 2008, in press; Levine et al., 2002), we also extended the pattern to picture description. Moreover, performance on the picture description task accounted for the bulk of variance in memory and imagination performance. Nonetheless, there was a

significant albeit modest contribution of aging to memory and imagination performance above-and-beyond picture description performance.

Our findings have a number of implications for the constructive episodic simulation hypothesis (Schacter & Addis, 2007), which holds that age deficits in imagining future events reflect a problem in retrieving details from prior episodes and recombining them into a novel imaginary scenarios. The similar performance of older adults on picture description, imagination, and memory tasks appears to indicate that mechanisms other than episodic memory are also relevant to understanding previous observations of parallel age-related declines in episodic specificity during memory and imagination.

For example, changes in narrative style (e.g., Coupland & Coupland, 1995; James et al., 1998; Labouvie-Vief & Blanchard-Fields, 1982), such that older adults maintain different communicative goals from younger adults – emphasizing personal meaning rather than a precise reiteration of events – could contribute to decreased internal and increased external details in older adults across all three tasks. Alternatively, age-related differences in the ability to inhibit task-irrelevant thought (e.g., Arbuckle & Gold, 1993; Zacks & Hasher, 1994) might result in fewer internal details as well as more details that are coded as external (for discussion, see Schacter, Gaesser, & Addis, in press). It is interesting to note in this regard that despite the possibility that the picture description task may be somewhat more concrete and constrained than the memory and imagination tasks, and therefore potentially less prone to influence from task-irrelevant thoughts, the identical pattern of internal and external details was observed across tasks. In any case, because our results do not distinguish between the foregoing hypotheses, future research will be needed to characterize the non-episodic sources of age differences in tasks like those used here. We think that such research could benefit from adopting new approaches to characterizing narrative discourse in older versus younger adults, such as that recently illustrated in recent work by Trunk and Abrams (2009).

Nonetheless, both experiments revealed that not all age-related reductions in internal details during memory and imagination were accounted for by picture description performance. These findings are consistent with the constructive episodic simulation hypothesis and indicate that age-related changes in processes emphasized by that hypothesis, such as impaired retrieval and recombination of episodic detail, merit further investigation. The finding from Experiment 2 that a small age deficit in imagination was observed even after controlling for memory performance raises the intriguing possibility that there are age-related changes in processes specific to imagination, such as recombining episodic details (Addis et al., in press; Addis & Schacter, 2008; Schacter & Addis, 2009).

Finally, our findings have implications for studies that have used the Autobiographical Interview to examine memory in various patient populations. (cf., Levine et al., 2002, 2009; McKinnon et al., 2006; Murphy et al., 2008; Rosenbaum et al., 2009; Rudoy et al., 2009). Such studies have typically attempted to distinguish episodic and semantic contributions to autobiographical memory based on Autobiographical Interview performance. However, our findings indicate that one cannot simply assume that Autobiographical Interview performance reflects specifically the operation of memory mechanisms (see also Rudoy et al. (2009) for discussion of some related issues). Future studies using the Autobiographical Interview will need to incorporate a condition such as the picture description task used here, in which narratives are collected that do not require episodic memory, in order to provide a broader characterization of between-group differences in Autobiographical Interview performance and potentially relevant higher-order cognitive processes.

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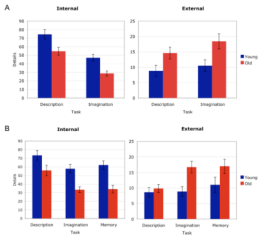

FIG. 1.

A) Mean number of internal and external details for Exp. 1 as a function of Age (Young, Old) and Task (Picture Description, Imagination). Error bars represent standard errors of the means. B) Mean number of internal and external details for Exp. 2 as a function of Age (Young, Old) and Task (Picture Description, Imagination, Memory). Error bars represent standard errors of the means.