Consciousness and Cognition 51 (2017) 258–267

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Exploring the experience of episodic past, future, and counterfactual thinking in younger and older adults: A study of a Colombian sample

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ARTICLE INFO

Keywords:
Episodic memory
Counterfactual thinking
Future thinking
Mental simulation
Autobiographical interview
Phenomenology
Aging

ABSTRACT

Although extant evidence suggests that many neural and cognitive mechanisms underlying episodic past, future, and counterfactual thinking overlap, recent results have uncovered differences among these three processes. However, the extent to which there may be age-related differences in the phenomenological characteristics associated with episodic past, future and counterfactual thinking remains unclear. This study used adapted versions of the Memory Characteristics Questionnaire and the Autobiographical Interview in younger and older adults to investigate the subjective experience of episodic past, future and counterfactual thinking. The results suggest that, across all conditions, younger adults generated more internal details than older adults. However, older adults generated more external details for episodic future and counterfactual thinking than younger adults. Additionally, younger and older adults generated more internal details, and gave higher sensory and contextual ratings, for memories rather than future and counterfactual thoughts. Methodological and theoretical consequences for extant theories of mental simulation are discussed.

1. Introduction

Recent evidence suggests remarkable overlap in the neural and cognitive mechanisms underlying episodic memory—our capacity to bring to mind specific events of our personal past (Tulving, 1985)—and episodic future thinking—our capacity to imagine specific events that may happen in our personal future (Atance & O'Neill, 2001; Szpunar, 2010). This claim is supported by neuropsychological evidence showing similar deficits in episodic memory and future thinking in individuals with amnesia (Hassabis, Kumaran, Vann, & Maguire, 2007; Klein, Loftus, & Kihlstrom, 2002; Tulving, 1983), severe depression (Dickson & Bates, 2005; Williams, 1996), schizophrenia (D'Argembeau, Raffard, & Van der Linden, 2008), amnestic mild cognitive impairment (Gamboz et al., 2010), and Alzheimer's disease (Addis, Musicaro, Pan, & Schacter, 2010; Addis, Sacchetti, Ally, Budson, & Schacter, 2009), among others. Further support comes from developmental studies showing parallel patterns of development for episodic memory and future thinking in

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http://dx.doi.org/10.1016/j.concog.2017.04.007
Received 14 April 2016; Received in revised form 17 February 2017; Accepted 11 April 2017
1053-8100/

young children (Busby & Suddendorf, 2005; Perner, Kloo, & Rohwer, 2010; Suddendorf & Busby, 2005) and older adults (Addis, Wong, & Schacter, 2008; Spreng & Levine, 2006), as well as neuroimaging studies showing significant overlap in brain regions engaged during episodic memory and future thinking (Addis, Wong, & Schacter, 2007; Okuda et al., 2003; Szpunar, Watson, & McDermott, 2007; for a recent review see Schacter et al., 2012). Finally, studies exploring the experience of episodic memory and future thinking have uncovered similarities in their phenomenological characteristics (D'Argembeau & Van der Linden, 2004, 2006; Szpunar & McDermott, 2008; Winfield & Kamboj, 2010), further supporting the claim that common mechanisms underlie both processes.

Although many initially interpreted the striking similarities between past and future thinking as evidence in favor of a cognitive system for mental time travel (Suddendorf & Corballis, 1997, 2007; Tulving, 1985)—the capacity to mentally travel back to our experienced past and forward to our imagined future—soon it became evident that this characterization needed to be extended to cover mental simulations of possible ways in which past events could have occurred but did not—a cognitive process known as *episodic counterfactual thinking* (De Brigard, 2014; De Brigard & Giovanello, 2012; Roese, 1997; Schacter, Benoit, De Brigard, & Szpunar, 2015). Support for this observation comes from neuroimaging results showing common engagement of brain regions during episodic memory, future and counterfactual thinking (De Brigard, Addis, Ford, Schacter, & Giovanello, 2013; De Brigard, Spreng, Mitchell, & Schacter, 2015; Van Hoeck et al., 2013; see also Addis, Pan, Vu, Laiser, & Schacter, 2009; Addis, Sacchetti et al., 2009). Further evidence comes from neuropsychological studies reporting abnormalities in counterfactual thinking in individuals with impairments in episodic memory and future thinking, such as schizophrenia (Hooker, Roese, & Park, 2000) and amnesia (Mullally & Maguire, 2014), both of which are associated with damage in the medial temporal lobes. Finally, recent behavioral results exploring episodic past, future and counterfactual thoughts found similarities in phenomenological features (De Brigard & Giovanello, 2012) as well as in the reliance of cultural life scripts as a function of temporal distance across these three kinds of simulations (Özbek, Bohn, & Berntsen, 2016).

Despite the similarities between episodic memory, future, and counterfactual thinking, a number of systematic differences have also been documented. Studies comparing episodic memory and future thinking have uncovered developmental differences, such as the fact that 3–4 year-old children appear to be able to discriminate (Friedman, 2005) and reason sequentially (McColgan & McCormack, 2008) about past events before they can do so with future events. Additionally, 9–15 year-old children seem to generate more coherent stories about past than future events (Bohn & Bernsten, 2013), although these are more creative and narratively richer than episodic memories (Busby & Suddendorf, 2005). As for healthy young adults, is has been found that during both involuntary and voluntary mental time travel, they report more positive thoughts when thinking about the future than the past (Bernsten & Jacobsen, 2008; Rasmussen & Bernsten, 2013). Furthermore, thoughts about the future tend to be more schematic and prototypical (Kane, Van Boven, & McGraw, 2012), and contain fewer details (D'Argembeau & Van der Linden, 2004) than thoughts about the past (see also Painter & Kring, 2015, for further differences).

Significantly less is known about differences between episodic counterfactual thinking as compared to episodic memories and future thoughts. De Brigard and Giovanello (2012) compared phenomenological characteristics of episodic past, future and counterfactual thoughts in young adults, and found that episodic memories were rated as more vivid, spatially coherent, and as containing more sensory details than both episodic future and counterfactual thoughts. Additionally, they found that emotion ratings for counterfactual thoughts were lower than for past and future thoughts. Repeated simulation also appears to affect episodic future and counterfactual thinking differently, as it seems to increase perceived plausibility in the former (Szpunar & Schacter, 2013) while decreasing it in the latter (De Brigard, Szpunar, & Schacter, 2013; Stanley, Stewart, & De Brigard, 2016). More recently, Özbek et al. (2016) also demonstrated that episodic memories were more specific, easily remembered and more likely to be experienced from a field perspective than both episodic future and counterfactual thoughts. Furthermore, they showed that future thoughts were experienced as more positive, important, voluntarily rehearsed and central to the person's life than episodic counterfactual thoughts.

These findings notwithstanding, there are still a number of open questions regarding the experience of engaging in episodic past and future thinking relative to episodic counterfactual thinking. One such question is whether or not there are age differences in the subjective experience of episodic counterfactual thinking between younger and older adults and, if so, whether or not these differences parallel those documented for episodic memory and future thinking. Although not many, a handful of studies have explored age-related differences in the subjective experience of episodic memory. Hashtroudi, Johnson, and Chrosniak (1990), for instance, asked younger and older participants to either remember or imagine ordinary situations, after which they were asked to complete the Memory Characteristics Questionnaire (MCQ, Johnson, Foley, Suengas, & Raye, 1988). Although they found that older adults reported more thoughts and feelings than younger adults, no differences were found in sensory and contextual ratings. However, a subsequent memory test revealed that older adults remembered fewer sensory and contextual details than younger adults, which is consistent with evidence showing that older adults exhibit more difficulties retrieving relations among elements than younger adults (Chalfonte & Johnson, 1996; Lyle, Bloise, & Johnson, 2006). Comblain, D'Argembeau, and Van der Linden (2005) also employed the MCQ to examine similarities and differences in the phenomenological experience of emotional versus neutral autobiographical memories in younger and older adults. They found that while both younger and older adults gave higher ratings for sensorial and contextual features of emotional relative to neutral memories, older adults reported more positive feelings and intensity for negative memories than younger adults, a results consistent with the documented "positivity bias" in old age (Mather & Carstensen, 2005). Finally, using a novel Autobiographical Interview (AI) Levine, Svoboda, Hay, Winocur, and Moscovitch (2002) showed that older adults recovered fewer episodic details but more external information when remembering autobiographical episodes than young adults.

Studies exploring age differences in episodic memory and future thinking are even scarcer, yet these few extend and complement previous findings in autobiographical memory. In a pioneer study exploring age-related differences and similarities in episodic memory and future thinking between younger and older adults, Spreng and Levine (2006) showed that the temporal remoteness of episodic past and future thoughts follows a logarithmic curve for both young and old adults. Soon after, Addis et al. (2008) used an adapted version of the AI to compare episodic past and future thoughts in younger and older adults, and found not only parallel effects for both past and future thinking but also similar differences between young and old, with younger adults generating more internal details and fewer external details for both episodic past and future thoughts than older adults. These findings were later corroborated using the same measure on a different paradigm (Addis et al., 2010), and were also shown to be independent of narrative ability (Gaesser, Sacchetti, Addis, & Schacter, 2011). Finally, a recent study by Rendell et al. (2012) showed that, relative to younger adults, older adults exhibited difficulties not only generating episodic future thoughts but also mental simulations that involved atemporal situations. However, they also found that older adults were more impaired during the future simulation task than the atemporal task.

Unfortunately, the extent to which these age-related differences extend to episodic counterfactual thinking remains unclear. The current study helps to clarify this issue by investigating the phenomenological characteristics of mental simulations during episodic past, future and counterfactual thinking in a sample of healthy young and old adults from Colombia. To that end, younger and older adults were asked to recall twelve past yet recent decision-making events. A week later they were asked to remember some of those events as they occurred, imagine an alternative way in which they could have occurred but did not, or imagine a possible future event in which a similar decision-making event could occur. Features of the participants' subjective experiences during these episodic past, future and counterfactual thoughts were measured using adapted forms of the MCQ (Appendix A; Johnson et al., 1988) and the AI (Levine et al., 2002), which allow us to test four hypotheses. First, and building upon previous studies employing the MCQ (Comblain, D'Argembeau, & Van der Linden, 2005), we hypothesized that MCQ ratings for sensory and contextual features will be higher for memories than for both counterfactual and future thoughts, regardless of age. Second, we hypothesized that counterfactual thoughts will have higher sensorial and contextual ratings than future thoughts, as they require less deviation from the original memory relative to future thoughts. Third, building upon previous studies employing the AI (Addis et al., 2008, 2010; Gaesser et al., 2011; Levine et al., 2002), we hypothesized that younger adults will generate more internal details for past, future and counterfactual thoughts than older adults who, in turn, would generate more external details across all three conditions relative to younger adults. Fourth, we expected a higher proportion of internal details for memories relative to both episodic future and counterfactual thoughts regardless of age whereas, consistent with previous results in younger adults (De Brigard & Giovanello, 2012), we expected a greater amount of external details for counterfactual versus episodic past and future simulations.

2. Method

2.1. Participants

18 younger adults (M_{age} = 19.10, SD = 1.80; 11 = Female, $M_{\text{Years-of-Education}}$ = 13.10, SD = 0.19) and 20 healthy older adults (M_{age} = 67.0, SD = 3.95; 7 = Female, $M_{\text{Years-of-Education}}$ = 12.80, SD = 0.97, $M_{\text{Mini Mental}}$ = 29.70, SD = 0.65) with no history of neurological or psychiatric impairment participated in this study. Two older adults failed to complete the experiment, so data from 18 older adults is included in this analysis. Younger adults were recruited through the participants pool available for freshman in the psychology department at the Universidad Nacional de Colombia. Older adults were selected from a volunteering list and contacted via phone. Older adults that could not travel to the Universidad Nacional were tested at their homes. All participants were Colombian citizens, native and monolingual Spanish speakers. Participants received $50,000 pesos (roughly, US$17) for their participation in the study. All participants gave consent following the ethical requirements of the Universidad Nacional de Colombia.

2.2. Materials and procedure

The paradigm employed in the present study was adapted from De Brigard and Giovanello (2012) and consisted of two sessions. In the first session, which took about one hour, participants were asked to complete an excel worksheet asking them to remember past personal events where they had to make a decision. To help them retrieve such memories, a list of typical decisions (e.g., choosing an entree) was provided. Participants were asked to retrieve memories of spatio-temporally specific autobiographical events and were asked to write a short description. Next, to verify that the memory corresponded to a decision-making event, participants were asked to remember other options they considered while making the decision just remembered. For instance, if the participant remembered being at a wedding and having to choose between the chicken and the pasta, they would have described the event as deciding to order the chicken, and would have included the pasta as the alternative choice. In addition, they were asked to describe the outcome of the decision, and to provide a short title of the event. Participants were told that this title would be used as a cue to help them retrieve each particular event during the second session, so they were advised to generate memorable titles. Participants were asked to generate 16 such memories, from which the best 12—i.e., those that best fit the above criteria as determined by the experimenter—were selected.

In the second session, which took place a week later, these 12 memories were randomly divided into three conditions, *remember, future* and *counterfactual,* for a total of four trials per condition. All trials had the same structure, and the order of presentation was counterbalanced across participants. Participants sat in front of a computer screen and were presented with a slide that included a heading with the name of the task (i.e., "Remember" [Recuerde], for the memory task; "Imagine" [Imagine], for the future task; and "What if…" [Qué tal si…], for the counterfactual task), followed by three components of the event: the time and place, the title given, and the outcome. In the remember trials, participants saw the three components (i.e., time and place, title, and outcome) that belonged to one of the chosen decision-making memories and were instructed to remember the displayed event with as much detail as possible. In the future trials, participants saw the three components of a reported decision-making memory and were instructed to imagine a possible moment in the future (i.e., next 10 years) where they may have to make a similar decision and to describe it with as much detail as possible. Participants were instructed to think of a new event, rather than recasting a past event. Finally, in the counterfactual trials, participants saw the three components of a reported decision-making memory and were instructed to imagine an alternative way in which the event could have occurred, had they chosen differently (e.g., "What if you have chosen pasta instead of chicken?"). Participants described their mental simulations out loud for up to three minutes while being recorded, and received no further prompting, unless their descriptions were too short (i.e., less than one minute), in which case the experimenter encouraged them to keep going saying "Is there anything else you can remember/imagine about this event?". At the end of each trial, participants completed a modified MCQ, adapted from Johnson et al. (1988), and previously used by De Brigard and Giovanello (2012) (see Appendix A).

2.3. Autobiographical interview scoring

The recordings of each participant's descriptions were transcribed and scored by three trained scorers following to the AI protocol (Levine et al., 2002). Scorers were blind to group and hypothesis. Following previous studies employing the AI to assess past, future and counterfactual mental simulations (Addis et al., 2008; De Brigard & Giovanello, 2012; Gaesser et al., 2011; Race, Keane, & Verfaellie, 2011), an adapted scoring system was employed. First, for each trial, a main event was identified. Scorers had access to the specific event description that cued each trial for each subject, so the main event was identified as the one that corresponded to the cue. All other events were considered external events. The transcription was then divided into distinct segments, such as unique occurrences or thoughts. Details concerning the main event were rated as *Internal*. All other details were considered *External*. External details included non-episodic information such as semantic details, repetitions, or editorial comments, as well as information concerning events different from the main event. For each trial, the number of internal and external details was tallied. Inter-rater reliability of scoring between coders was established on the basis of an interclass correlation analysis for all the tallied scores (Cronbach's $\alpha = 0.83$).

3. Results

3.1. Phenomenological characteristics

Consistent with previous studies using phenomenological characteristics questionnaires for past (Schaefer & Philippot, 2005; Suengas & Johnson, 1988), future (D'Argembeau & Van der Linden, 2004) and counterfactual thoughts (De Brigard & Giovanello, 2012), ratings of clarity, color, visual detail, sound, smell, touch, taste, vividness and overall sense of simulation were averaged into a single *sensory* phenomenological factor (Cronbach's $\alpha_{young} = 0.87$; $\alpha_{old} = 0.88$); ratings of composition, clarity of location, objects, people and time of day were averaged into a *composition* factor ($\alpha_{young} = 0.90$, $\alpha_{old} = 0.85$). Ratings of intensity during the event (*intensity then*), intensity as the event is simulated (*intensity now*), emotion during the event (*emotion then*), and emotion as the event is simulated (*emotion now*), were analyzed as separate factors. Ratings for the resultant phenomenological factors (Table 1) were modeled as five independent mixed-design 2 × 3 ANOVAs, with age Group (younger, older) as between-subjects factor and Condition

Table 1
Mean ratings for phenomenological factors. Standard deviations are in parenthesis.

Characteristic	Remember	CFT	Future
Sensory			
Younger	4.15 (0.68)	3.77 (0.77)	3.42 (0.91)
Older	4.93 (0.96)	4.61 (1.07)	4.42 (1.18)
Composition			
Younger	5.48 (0.72)	4.92 (0.75)	4.38 (1.26)
Older	6.24 (0.69)	5.82 (0.94)	5.58 (1.00)
Intensity Then			
Younger	4.83 (0.85)	4.60 (1.20)	4.39 (1.08)
Older	5.82 (1.19)	5.93 (0.86)	5.60 (1.01)
Intensity Now			
Younger	4.44 (1.05)	4.26 (0.97)	3.99 (1.21)
Older	5.67 (1.50)	5.88 (0.88)	5.42 (1.17)
Emotion Then			
Younger	4.14 (1.08)	3.88 (1.11)	4.11 (0.78)
Older	4.86 (1.48)	5.00 (.87)	5.15 (1.06)
Emotion Now			
Younger	4.38 (1.10)	3.86 (1.01)	4.10 (0.83)
Older	5.07 (1.50)	5.54 (1.26)	5.18 (1.38)

(Remember, CFT, Future) as within-subjects factor.

Sensory: The analysis revealed a main effect of Condition, $F(2,33) = 7.72$, $p = 0.002$, $\eta^2 = 0.32$, with no interactions. Pairwise contrasts indicated that, regardless of age, sensory ratings were significantly higher for Remembering than both CFT, $t(35) = 2.40$, $p = 0.02$, $d = 0.36$, and Future, $t(35) = 3.92$, $p < 0.001$, $d = 0.60$. However, there were no differences between CFT and Future. There was also a main effect of Group, $F(1,34) = 11.69$, $p = 0.002$, $\eta^2 = 0.26$, indicating that sensory ratings were overall higher for older than for younger adults.

Composition: The analysis revealed a main effect of Condition, $F(2,33) = 14.09$, $p < 0.001$, $\eta^2 = 0.46$, with no interaction. Pairwise contrasts indicated that, regardless of age, composition ratings were significantly higher for Remembering than both CFT, $t(35) = 3.78$, $p = 0.001$, $d = 0.56$, and Future, $t(35) = 5.02$, $p < 0.001$, $d = 0.83$. In turn, composition ratings for CFT were significantly higher than Future, $t(35) = 2.28$, $p = 0.03$, $d = 0.35$. There was also a main effect of Group, $F(1,34) = 15.28$, $p < 0.001$, $\eta^2 = 0.31$, indicating that overall older adults gave higher ratings of composition than younger adults.

Intensity then: The analysis revealed a main effect of Group, $F(1,34) = 20.57$, $p < 0.001$, $\eta^2 = 0.38$, with no interaction, indicating that overall older adults gave higher ratings of intensity during the event than younger adults.

Intensity now: The analysis revealed a main effect of Group, $F(1,34) = 21.81$, $p < 0.001$, $\eta^2 = 0.39$, with no interaction, indicating that overall older adults gave higher ratings of intensity during simulation than younger adults.

Emotion then: The analysis revealed a main effect of Group, $F(1,34) = 15.79$, $p < 0.001$, $\eta^2 = 0.32$, with no interaction, indicating that overall older adults gave higher ratings of emotion during the event than younger adults.

Emotion now: The analysis revealed a main effect of Group, $F(1,34) = 19.93$, $p < 0.001$, $\eta^2 = 0.37$, with no interaction, indicating that overall older adults gave higher ratings of emotion during simulation than younger adults

3.2. Autobiographical interview

Scores for internal and external details (Fig. 1) were modeled as two mixed-design 2 × 3 ANOVAs with age Group (younger, older) as a between-subject factor and Condition (Remember, CFT, Future) as a within-subject factor. For *internal details*, this analysis revealed a main effect of Group, $F(1,33) = 5.19$, $p = 0.03$, $\eta^2 = 0.14$, indicating that younger adults produced more internal details across all three conditions than older adults (for *M*s and *SD*s, see below). In addition, there was also a main effect of Condition, $F(2,32) = 21.75$, $p < 0.001$, $\eta^2 = 0.58$, with no interaction. Follow-up pairwise comparisons indicated that both younger and older adults generated more internal details in the Remember condition ($M_{younger} = 20.74$, SD = 12.27; $M_{older} = 15.49$, SD = 8.31) than the Future ($M_{younger} = 15.90$, SD = 11.57; $M_{older} = 8.69$, SD = 3.66), $t(34) = 6.71$, $p < 0.001$, and the CFT conditions ($M_{younger} = 13.36$, SD = 11.31; $M_{older} = 6.63$, SD = 2.06), $t(34) = 5.14$, $p < 0.001$. In turn, both groups produced more internal details in the Future condition than the CFT condition, $t(34) = 3.53$, $p = 0.001$.

For *external detail*, this analysis revealed a main effect of Group, $F(1,33) = 4.07$, $p = 0.05$, $\eta^2 = 0.11$, modified by a Group by Condition interaction, $F(2,32) = 6.42$, $p = 0.005$, $\eta^2 = 0.29$ (for *M*s and *SD*s, see below). To clarify this interaction, independent sample *t*-tests were conducted for each condition. This analysis revealed that older adults produced more external details for the CFT condition ($M_{older} = 9.23$, SD = 4.11), $t(33) = 2.63$, $p = 0.01$, than younger adults ($M_{younger} = 5.71$, SD = 3.85). Likewise, older adults produced more external details for the Future condition ($M_{older} = 9.01$, SD = 4.23), $t(33) = 3.98$, $p < 0.001$, than younger adults ($M_{younger} = 4.28$, SD = 2.69). However, there were no differences for the Remember condition.

Finally, on average, participants generated more segments for the Remember ($M_{younger} = 24.87$, SD = 15.04; $M_{older} = 20.31$, SD = 13.01) than the CFT ($M_{younger} = 16.51$, SD = 8.62; $M_{older} = 14.64$, SD = 6.44) and Future conditions ($M_{younger} = 17.52$, SD = 11.13; $M_{older} = 16.19$, SD = 7.61), $F(1,33) = 20.13$, $p < 0.001$, $\eta^2 = 0.23$. Critically, there were no differences in number of segments between groups ($p > 0.05$).

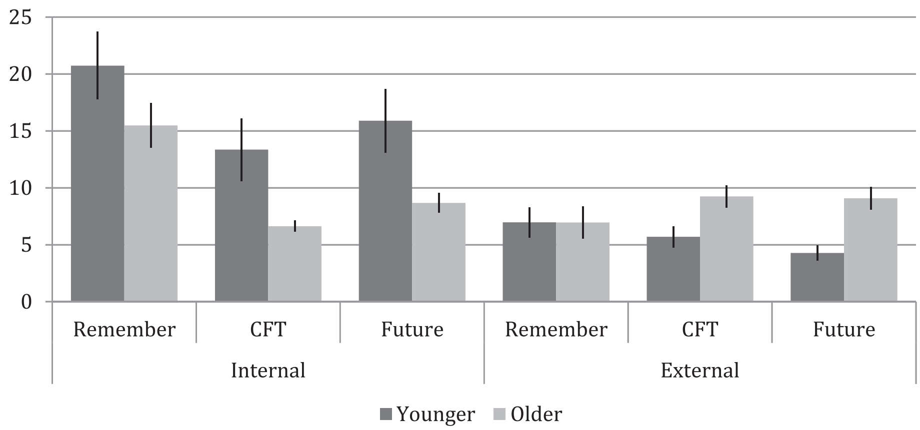

Fig. 1. Mean number of Internal and External details (Y axis) as a function of Condition (X axis: Remember, CFT, Future) for Younger and Older adults, following scoring from the adapted Autobiographical Interview. Error bars indicate *SEM*.

4. Discussion

The current study explored similarities and differences in phenomenological characteristics of mental simulations during episodic past, future and counterfactual thinking in a sample of healthy younger and older adults from Colombia. We employed two strategies to measure participants' phenomenological characteristics while engaging in these simulations: a modified set of MCQs and an adapted version of the AI (Addis et al., 2008, 2010; De Brigard & Giovanello, 2012). On the one hand, the results of the MCQ ratings yielded three main findings: (1) Both younger and older adults reported higher ratings of sensory and composition details for episodic memories than for episodic counterfactual and future simulations. (2) Although composition ratings were highest for remembering, counterfactual simulations received higher ratings for composition relative to future simulation for both younger and older adults. (3) Overall, older adults gave higher ratings across all measures—i.e., sensory, composition, intensity and emotion—relative to younger adults.

On the other hand, the results of the adapted AI yielded three main findings: (1) Younger adults generated on average more internal details across all three mental simulations—i.e., remembering, counterfactual and future thinking—than older adults. (2) Both younger and older adults generated more internal details for episodic memories relative to both episodic future and counterfactual thinking. In turn, both groups generated more internal details for future than counterfactual thoughts. Finally, (3) older adults generated more external details for episodic counterfactual and future thoughts than younger adults.

As mentioned above, the current study aimed to test four hypotheses. First, we hypothesized that, regardless of age, MCQ ratings for sensory and contextual features will be higher for memories than for both counterfactual and future thoughts. The results from the MCQ speak in favor of this hypothesis, as it was found that sensory and contextual (i.e., composition) features were higher for episodic memories than for both counterfactual and future simulations. This result is consistent with previous studies employing the MCQ whereby memories received higher ratings for sensory and contextual details than imaginations (Johnson et al., 1988; McGinnis & Roberts, 1996). These observations have been corroborated by direct comparisons between episodic memories and imagined possible future personal events (D'Argembeau & Van der Linden, 2004). Moreover, these results replicate those of De Brigard and Giovanello (2012), who found higher ratings for sensory and contextual components in episodic memory than both future and counterfactual simulations in younger adults, while at the same time extending these findings to older adults, who appear to exhibit the same pattern.

Second, and relatedly, we hypothesized that counterfactual thoughts will have higher sensorial and contextual ratings than future thoughts, since it has been suggested that they require less deviation from the experienced event relative to other kinds of hypothetical simulations, such as episodic future thoughts (Byrne, 2002; De Brigard, Szpunar et al., 2013). The results of the MCQ partly corroborated this hypothesis, as they revealed higher contextual (albeit not sensory) details for episodic counterfactual relative to episodic future thoughts. These results suggest that episodic counterfactual thoughts may inherit much of the contextual coherence with which they are experienced from the episodic memory they are derived from. In addition, they also agree with recent results suggesting that episodic future thoughts tend to be more schematic than episodic memories (Kane et al., 2012), perhaps because the former involves comparatively more semantic information than the latter (Irish, Addis, Hodges, & Piguet, 2012). As such, the higher contextual ratings of episodic counterfactual thoughts relative to episodic future thoughts may indicate that the former involve less schematic and/or semantic information that the latter, although more so than the episodic memories from which they are generated.

Third, and following previous studies employing the AI (Addis et al., 2008, 2010; Gaesser et al., 2011; Levine et al., 2002), we hypothesized that younger adults will generate more internal details for past, future and counterfactual thoughts than older adults who, in turn, would generate more external details across all three conditions relative to younger adults. The results of the AI speak in favor of this third hypothesis, as it was found that younger adults generated on average more internal details across all simulations than older adults. This result is consistent with prior studies employing the AI where it has been found that younger adults generate on average more internal details for both autobiographical memories (Levine et al., 2002) and episodic future thoughts (Addis et al., 2008, 2010; Gaesser et al., 2011) than older adults. These results have been interpreted as suggesting an age-related reduction in the episodic specificity for both episodic memories and future simulations. The current results support this observation while extending it to episodic counterfactual thinking. Moreover, and consistent with the aforementioned results, the findings of the current study also indicate that older adults generated on average more external details than younger adults. However, unlike prior studies, this pattern of results was only evident for episodic future and counterfactual simulations, but not for episodic memories. A possible explanation for this null effect of group on external details in the remembering condition may be due to the level of education of the sample of participants in the current study. Unlike prior studies, the older adults in the current study had completed fewer years of education (M = 12.8) as compared to, for instance, those in Levine et al. (2002; M = 14.0), or in Addis et al. (2010; M = 16.39). Since the inclusion of semantic information in the narrative of episodic simulations may depend upon the participant's general knowledge, this difference in education may account for the discrepancy between these prior findings and the current ones. We believe that further research is needed to clarify the role of years of education in the number of external details generated during the description of episodic simulations of past, future and counterfactual events.

Finally, as stated in the fourth hypothesis tested in this study, we expected to find a higher proportion of internal details for memories relative to both episodic future and counterfactual thoughts regardless of age. Additionally, and consistent with previous studies conducted with younger adults (De Brigard & Giovanello, 2012), we expected to find a greater number of external details for counterfactual versus episodic past and future simulations in both younger and older adults. The results from the current study clearly support the first part of this last hypothesis, as it was found that both younger and older adults generated more internal details for episodic memories than for episodic counterfactual and future thoughts. These results are consistent with previous findings employing the AI in episodic memories and future simulations (Addis et al., 2008, 2010), suggesting that thinking about our personal pasts involves a richer and more detailed episodic simulation than thinking about possible future as well as possible past events that could have occurred but did not happen. These results also agree with the MCQ findings mentioned above, whereby both younger and older adults gave higher ratings of sensorial and contextual details to episodic memories versus both episodic future and counterfactual thoughts. Moreover, this pattern of results replicates those found by De Brigard and Giovanello (2012) while extending them to older adults. Consistent with previous interpretations of these results (e.g., Addis et al., 2010; De Brigard & Giovanello, 2012), and in agreement with the *constructive episodic simulation hypothesis* (Schacter & Addis, 2007), we take these findings as lending credence to the claim that the mental construction of episodic memories involves less recombination of sensory and spatial components than both episodic and future simulations, which in turn renders memories to be experienced as more vivid and cohesive than imaginative simulations.

The results from the current study are less clear regarding the second part of this last hypothesis (namely, that regardless of age there would be a greater number of external details for counterfactual relative to episodic past and future simulations) as it was indeed found that counterfactual thoughts involved more external details than episodic memories, but this was only evident for older adults. Moreover, contrary to the observation in younger adults from De Brigard and Giovanello (2012), there was no difference in the proportion of external details between episodic counterfactual and future thoughts in either younger or older adults. Given the dearth of studies on counterfactual thinking in older adults, it is unclear how to account for this result. What is clear, however, is that further studies are needed to help to clarify differences in mental simulations of counterfactual and future thoughts in older adults.

Before concluding, it is worth noting one result from the current study about which we did not have a prior hypothesis: namely that, overall, older adults gave higher ratings across all phenomenological measures—i.e., sensory, composition, intensity and emotion—than younger adults. This may suggest that, in general, older adults have a more coherent, vivid, intense and emotionally salient experience during episodic past, future and counterfactual thinking than younger adults. Although surprising, this result actually agrees with previous findings on autobiographical memory research, where it has been found that older adults give higher ratings of vividness and reliving than younger adults (De Brigard et al., 2016; Janseen, Rubin, & St. Jacques, 2011; Kingo, Berntsen, & Krøjgaard, 2013; Rubin & Berntsen, 2009; Rubin & Schulkind, 1997). Importantly, this age-related increase in experienced vividness and reliving during autobiographical recollection is independent of both the remoteness of the retrieved event as well as the accuracy of its contents. As such, it may be possible that the same age-related increase in vividness and reliving observed in episodic memory may be present during episodic counterfactual and future thinking, further supporting the strong similarities across these three kinds of mental simulations (De Brigard, 2014). However, the fact that for both the sensory and composition components there was also an effect of condition, suggests that there are important differences between episodic memory and episodic counterfactual and future thinking that merit further scrutiny. Additionally, it is worth noting that some authors have remarked that there may be differences in the use of subjective scales between younger and older adults (Comblain, D'Argembeau, & Van der Linden, 2005; McDonough & Gallo, 2013; Schlagman, Kliegel, Schulz, & Kvavilashvili, 2009). As such, we cannot rule out that these biases may explain at least part of the group effect found with the use of the MCQ ratings. Without a doubt, further research is needed to investigate the reliability of phenomenological questionnaires, such as the MCQ, across the lifespan.

Acknowledgments

We thank participants, research assistants Cristian Alfredo Triviño Martinez, Wilson Daniel Ossa, Diana Sofia Contreras Gutiérrez, Oscar Daniel Ayala Nariño, and professor María Fernanda Lara Díaz for their help. Thanks also to Rosemary Yin, Gregory Stewart, and two anonymous reviewers for useful comments on the manuscript.

Appendix A

Memory characteristics questionnaire

1. Clarity (1 = dim; 7 = clear).
2. Color (1 = black and white; 7 = full color).
3. Visual detail (1 = none; 7 = a lot).
4. Sound (1 = none; 7 = a lot).
5. Smell (1 = none; 7 = a lot).
6. Touch (1 = none; 7 = a lot).
7. Taste (1 = none; 7 = a lot).
8. Vividness (1 = vague; 7 = very vivid).
9. Composition (1 = sketchy; 7 = very detailed).
10. Clarity of location (1 = vague; 7 = clear).
11. Clarity of spatial arrangement of objects (1 = vague; 7 = clear).
12. Clarity of spatial arrangement of people (1 = vague; 7 = clear).
13. Clarity of time of day (1 = vague; 7 = clear).
14. Do you remember how you felt during the event? (1 = not at all; 7 = definitively).
15. Emotion during the event (1 = negative; 7 = positive).
16. Intensity of emotion during the event (1 = not intense; 7 = very intense).
17. Emotion as you are remembering now (1 = negative; 7 = positive).

18. Intensity of the emotion as you are remembering now (1 = not intense; 7 = very intense).
19. Overall, how do you remember this event? (1 = hardly; 7 = very well).

Autobiographical counterfactual characteristics questionnaire

1. Clarity (1 = dim; 7 = clear).
2. Color (1 = black and white; 7 = full color).
3. Visual detail (1 = none; 7 = a lot).
4. Sound (1 = none; 7 = a lot).
5. Smell (1 = none; 7 = a lot).
6. Touch (1 = none; 7 = a lot).
7. Taste (1 = none; 7 = a lot).
8. Vividness (1 = vague; 7 = very vivid).
9. Composition (1 = sketchy; 7 = very detailed).
10. Clarity of location (1 = vague; 7 = clear).
11. Clarity of spatial arrangement of objects (1 = vague; 7 = clear).
12. Clarity of spatial arrangement of people (1 = vague; 7 = clear).
13. Clarity of time of day (1 = vague; 7 = clear).
14. Can you imagine how would you've felt during the event? (1 = not at all; 7 = definitively).
15. What would have been your emotion? (1 = negative; 7 = positive).
16. What would have been the intensity of your emotion? (1 = not intense; 7 = very intense).
17. Emotion as you are thinking now (1 = negative; 7 = positive).
18. Intensity of the emotion as you are thinking now (1 = not intense; 7 = very intense).
19. Overall, how do you imagine this event? (1 = hardly; 7 = very well).

Future characteristics questionnaire

1. Clarity (1 = dim; 7 = clear).
2. Color (1 = black and white; 7 = full color).
3. Visual detail (1 = none; 7 = a lot).
4. Sound (1 = none; 7 = a lot).
5. Smell (1 = none; 7 = a lot).
6. Touch (1 = none; 7 = a lot).
7. Taste (1 = none; 7 = a lot).
8. Vividness (1 = vague; 7 = very vivid).
9. Composition (1 = sketchy; 7 = very detailed).
10. Clarity of location (1 = vague; 7 = clear).
11. Clarity of spatial arrangement of objects (1 = vague; 7 = clear).
12. Clarity of spatial arrangement of people (1 = vague; 7 = clear).
13. Clarity of time of day (1 = vague; 7 = clear).
14. Can you imagine how you will feel during the event? (1 = not at all; 7 = definitively).
15. Emotion during the event (1 = negative; 7 = positive).
16. Intensity of emotion during the event (1 = not intense; 7 = very intense).
17. Emotion as you are imagining now (1 = negative; 7 = positive).
18. Intensity of the emotion as you are imagining now (1 = not intense; 7 = very intense).
19. Overall, how do you imagine this event? (1 = hardly; 7 = very well).

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