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Time spent imagining does not influence younger and older adults' episodic simulation of helping behavior

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ABSTRACT

Shared cognitive processes underlie our ability to remember the past (i.e., episodic memory) and imagine the future (i.e., episodic simulation) and age-related declines in episodic memory are also noted when simulating future scenarios. Given older adults' reduced cognitive control and protracted memory retrieval time, we examined whether imposing time limits on episodic simulation of future helping scenarios affects younger and older adults' willingness to help, phenomenological experience, and the type of details produced. Relative to a control task, episodic simulation increased younger and older participants' willingness to help, scene vividness, and perspective-taking regardless of the time spent imagining future helping scenarios. Notably, time spent imagining influenced the number, but not proportion of internal details produced, suggesting that participants' use of episodic-like information remained consistent regardless of the time they spent imagining. The present findings highlight the importance of collecting phenomenological experience when assessing episodic simulation abilities across the lifespan.

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Episodic simulation; aging; scene vividness; perspective taking; helping behavior

1. Introduction

Our ability to imagine hypothetical scenarios enables us to mentally travel beyond our current state to reconsider past events, plan for the future, and problem solve (Schacter & Addis, 2007). Simulating hypothetical future scenarios (i.e., episodic simulation) has been shown to shift our intentions and shape our future choices and behaviors, such that imagining future events makes plausible hypothetical scenarios feel more likely to occur and predicts whether participants will engage in the imagined behavior in the future (Enz & Tamir, 2023; Garcia Jimenez et al., 2023; Gregory et al., 1982; Libby et al., 2007). For instance, asking participants to imagine future scenarios in which they help a person in need has been shown to increase willingness to help and subsequent monetary donations relative to control conditions (Gaesser & Schacter, 2014; Gaesser et al., 2018).

Reconstructing past and simulating future events rely on similar neurocognitive processes. The *constructive episodic simulation hypothesis* posits that remembering the past

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and imagining the future both involve recombining details from our previous experiences to remember the past and simulate hypothetical events (Schacter & Addis, 2007). These reconstructive processes share similar neural underpinnings (Benoit & Schacter, 2015) and may exhibit a parallel decline with age (Addis et al., 2008, 2010; Devitt et al., 2017). Strong correlations have been found between the number of details produced when individuals remember the past and imagine future scenarios, such that past and future internal (episodic-like) details were correlated, as were past and future external (semantic-like) details. Relatedly, there is a negative relationship between internal and external details when remembering past and imagining future scenarios (Devitt et al., 2017). Notably, older adults generate fewer internal details than younger adults both when remembering past and imagining future scenarios (Addis et al., 2008), and such findings have also been noted during problem solving tasks. Compared to younger adults, older adults produce fewer episodic-like details and relevant solutions on problem solving tasks with predetermined outcomes (i.e., means-end problem solving; Madore & Schacter, 2014; Sheldon et al., 2011; Vandermorris et al., 2013).

Nevertheless, a growing body of research suggests that older adults may be able to simulate events in order to solve social problems (Gaesser et al., 2017; Ryan, O'Connor, et al., 2023; Ryan, Smitko, et al., 2023; Sawczak et al., 2019). When asked to imagine future events in which they help a person in need with a specific problem, both older and younger adults exhibited an increase in their willingness to help compared to a semantic control condition (i.e., thinking about the journalistic style of the problem scenario; Gaesser et al., 2017; Ryan, O'Connor, et al., 2023). Moreover, older and younger adults also showed evidence of successful simulation as evidenced by an increase in their subjective scene imagery and theory of mind ratings (Ryan, O'Connor, et al., 2023; Ryan, Smitko, et al., 2023). Notably, the lack of age difference on these phenomenological measures suggested that the effect of episodic simulation was comparable in both age cohorts. However, when asked to describe their imagined future scenarios, older adults exhibited the typical pattern of producing fewer internal (and more external) details than younger adults (Ryan, O'Connor, et al., 2023). Thus, there appears to be a discrepancy between objective and subjective measures of episodic simulation, with objective measures (i.e., number of details produced) indicating an age-related impairment, and subjective measures (i.e., willingness to help and various phenomenological measures) suggesting that simulation is spared with age.

This discrepancy may reflect the extent to which a given measure, or simulation task, taps into episodic memory as opposed to semantic knowledge. According to the *semantic scaffolding hypothesis*, semantic memory acts as a framework upon which episodic memories are recalled and future simulations are built (Irish et al., 2012). Semantic memory is known to be preserved or even increased with age (Umanath & Marsh, 2014) and this may allow for preserved scaffolding of future simulations in older adults, especially when they can make use of existing knowledge (e.g., when the problem scenario is familiar or relevant to them; Artistico et al., 2019; Ryan, Smitko, et al., 2023). Indeed, episodic retrieval takes longer than (relatively automatic) semantic retrieval in both younger and older adults and this timing difference is even more pronounced in older adults (Spaniol et al., 2006). As such, the increased demands associated with episodic retrieval may help explain why older adults are found to produce more external (i.e., semantic-like) details when remembering the past and imagining the future. Indeed, age-related reductions in processing speed are well established (Salthouse, 2010), and research suggests this slowing may be (at least partly) responsible for age-related declines in episodic retrieval (see Verhaeghen, 2011, for a meta-analysis). Because of the shared neurocognitive underpinnings of episodic memory and simulation (Benoit & Schacter, 2015), it is conceivable that slowed episodic retrieval may influence the details older adults are able to produce when imagining future scenarios. To date, research examining age differences in episodic simulation has provided younger and older adults with unlimited time to imagine future helping events (Gaesser et al., 2017; Ryan, Smitko, et al., 2023), or restricted participants' time spent imagining to 3-minute (Addis et al., 2008) or 1-minute periods (Ryan, O'Connor, et al., 2023). Thus, the aim of the current study was to examine the effect of time spent imagining on older and younger adults' production of internal and external details, as well as their phenomenological experience of the simulated event.

1.1. Current study

In this study, older and younger adults were given short problem scenarios (taken from Gaesser & Schacter, 2014) that described a person in need (e.g., "This person has been locked out of their house"). Using within-subjects design, half of the presented scenarios prompted participants to imagine a vivid scene in which they helped the person in need and the other half prompted participants to complete a control condition in which they judged a potential media source for the story. To manipulate the duration of the time spent in each condition, we pseudorandomized the duration that participants were on the prompt screen (and able to write their imagined scenarios) for either 45, 60, or 75 seconds. In the past, we have limited participants' time spent imagining to 60 seconds (Ryan, O'Connor, et al., 2023), which provided adequate time for younger and older adults to imaging future helping scenarios. As such, 60 seconds was used as a starting point for our time manipulation, which allowed for comparison to our previous work. The 45s time was selected to restrict time spent imagining while still allowing participants enough time to write a response, and the 75s time was selected to see if additional time was helpful for older adults. The timing manipulation was pseudorandomized such that no more than 2 trials in a row lasted for the same duration. Immediately after the condition prompt, participants rated each story on a number of phenomenological metrics (see section 2.3) and their willingness to help the person in need. We were particularly interested in how reduced time spent imagining would influence the type of details produced by older adults, given that previous work in which older adults produce fewer internal details than older adults gave all participants the same limited amount of time to complete the task (Addis et al., 2008; Ryan, O'Connor, et al., 2023). We hypothesized that older adults would be further disadvantaged by the reduced time spent imagining and that this would result in older adults producing fewer internal details and reporting reduced scene vividness when time is more limited.

2. Methods

2.1. Participants

Based on previous research that has tested this paradigm in online samples (Gaesser et al., 2018; Ryan, O'Connor, et al., 2023), we aimed to test 100 younger (18–35 years) and 100 older adults (60–80 years). This gave us 95% power to detect a small effect (Cohen's *f* = .06) in the age by time interaction. Canadian residents were recruited online through the Qualtrics' Research Panel. Participants self-screened into the study by reporting being fluent in English with no history of stroke, neurological conditions (e.g., epilepsy), cognitive impairment (e.g., dementia, Alzheimer's) or psychiatric issues (e.g., schizophrenia or bipolar disorder). In total, 230 participants completed the study, 2 younger adults were removed for typing gibberish in the open-ended responses. A further 5 younger and 2 older adult participants were removed for taking ≥2.5 SD than their age cohort to complete the study. A final 11 younger and 2 older adults were removed from analyses due to having too many incorrect trials (see data screening for more information). The final sample consisted of 97 younger adults ($M = 27.54$ $SD = 5.09$, between the ages of 18–35) and 111 older adults ($M = 66.04$, $SD = 4.43$, between the ages of 60–78) with usable data. In the younger group, 16.5% self-identified as Asian, 2.1% as Black or African-Canadian/American, 6.2% as Canadian (including French Canadian), 3.1% as Filipino, 2.1% as Hispanic or Latina American, 7.2% as Indian (including South Indian), 3.1% as Middle Eastern, 4.1% as Mixed Ethnicity, 4.1% as Unknown/Prefer not to answer, and 51.5% White, Caucasian, or European. In the older group, 1.8% self-identified as Asian, 0.9% as Black or African-Canadian/American, 25.2% as Canadian (including French Canadian), 0.9% as Hispanic or Latin American, 0.9% as Indian (including South Indian), 1.8% as Indigenous Peoples of the Americas, 0.9% as Middle Eastern, 0.9% as Unknown/Prefer not to answer, and 66.7% as White, Caucasian, or European.

2.2. Procedure

The paradigm used in this study was adapted from previous research on episodic simulation of helping behavior (Gaesser & Schacter, 2014; Ryan, O'Connor, et al., 2023). Participants were presented with one-line stories depicting everyday examples of people in need of help (e.g., This person is locked out of their house; see Supplementary Information for a list of stories). Conditions were presented in blocks with participants asked to either: 1. focus on the story by considering its journalistic style and online media source (control condition) or 2. imagine a vivid scenario of helping the person in need (episodic simulation condition). Half of the participants completed the control condition first, while the other half completed the episodic simulation condition first. The time spent on each condition prompt was either 45, 60, or 75 seconds. Time allotted for the condition prompts was pseudorandomized to ensure that no more than 2 trials in a row were presented for the same number of seconds. Time spent on the condition prompts and block presentation order were fully counterbalanced.

At the beginning of each block, participants were presented with the instructions for their task and completed two practice trials to become familiar with the task. Participants then confirmed whether they understood the instructions and those who reported understanding the instructions were forwarded to the experiment, while further instructions and examples were given to those who indicated that they did not understand the instructions. Given the online nature of data collection, anyone reporting to not understand the instructions after two rounds of instructions and practice trials were excluded from the study.

For each trial, participants were presented with a story for 10 seconds, followed by a condition prompt. During the condition prompt, participants were asked to provide written descriptions of the scenes they imagined or describe where they thought the story may have originated (e.g., Twitter, local news). Immediately after the prompt, participants were asked how willing they would be to help the person in need (1 = not at all − 7 = very willing). Participants also rated the stories in terms of scene coherence (1 = vague − 7 = coherent and clear) and detail (1 = simple − 7 = detailed), whether the story made the participants feel troubled, distressed, sympathetic, compassionate, worried, and moved (1 = not at all − 7 = extremely for each emotion), and as a measure of perspective taking, participants were asked to rate how much they considered the thoughts and feelings of the person in need (1 = not at all − 7 = a great deal). Participants completed 18 trials with nine in each condition block, and three in each time condition. Participants then completed the Multifactorial Memory Questionnaire (MMQ), a tool used to measure metamemory in middle-aged and older adults (Troyer & Rich, 2002), and a demographics questionnaire.

2.3. Data scoring and screening

Participants' open-ended descriptions were used to score each trial as being completed correctly or incorrectly. As with previous research (Ryan, O'Connor, et al., 2023), incorrect trials were defined as those in which participants explicitly mention performing the opposite task (e.g., judging the journalistic style of a story on an imagine helping trial). Participants with ≥ 50% of their trials performed incorrectly were excluded from the study (see section 2.1); in the final sample, incorrectly performed trials were excluded from the analyses.

Participants' open-ended responses were also used to score their descriptions of imagined events in terms of internal (episodic-like) and external (semantic information, commentary, repetitions) details, using an adapted version of the autobiographical interview (Levine et al., 2002). Internal details have been shown to correlate with remembered and imagined scene vividness (Moscovitch et al., 2016; Thakral et al., 2020; Armson et al., 2021; cf:; Kensinger et al., 2011), and are used as a proxy for objective scene vividness in the current study. In line with previous research (Gaesser et al., 2018; Ryan, O'Connor, et al., 2023), the scales measuring the emotions felt in response to each scenario were averaged to form an "emotional concern index," as were ratings of scene coherence and detail to form a "scene vividness index" reflecting the overall vividness of the scene in participants' minds (Batson, 2011; Gaesser et al., 2017).

2.4. Analytic plan

To test whether episodic simulation, age, and time spent in the condition influenced willingness to help, scene vividness, emotional concern, and perspective taking, we constructed hierarchical mixed effects models for each dependent variable in R, using the lmer package. Random effects of participant id and story number and the following fixed factors were added to the model one at a time: 1) Condition, 2) Age, 3) Condition × Age, 4) Time Spent on Condition, 5) Condition × Time Spent on Condition, 6) Age × Time Spent on Condition, 7) Condition × Age × Time Spent on Condition. To test whether age, and time spent on the condition influenced the internal and external details produced on simulated trials only, separate models were run for each detail type with the following fixed factors added to the model one at a time: 1) Age, 2) Time Spent on Condition, 3) Age × Time Spent on Condition. We compared the models at each hierarchical step using a likelihood ratio test, and only predictors that improved model fit were retained to construct the best fit model (Sommet & Morselli, 2017). Follow-up modeling was conducted to explore the nature of interactions when appropriate.

3. Results

3.1. Effects of condition and time manipulation on participant ratings

3.1.1. Willingness to help

The model predicting willingness to help included participant id (ICC = 0.35) and story number (ICC = 0.42) as random effects, $\chi2(1) = 297.87$, $p < .001$. Condition, $\chi2(1) = 419.01$, $p < .001$, and the condition by age interaction, $\chi2(1) = 36.81$, $p < .001$, were found to improve model fit and were retained for the best fit model. The timing manipulation and all other predictors did not improve model fit, *p's* > .506.

The best fit model for willingness to help revealed an effect of condition, $B = 0.63$, $SE = 0.06$, $t(3316.45) = 9.83$, 95% *CI* [0.50, 0.75], with participants reporting a greater willingness to help following episodic simulation ($M = 5.37$, $SE = .13$) compared to the control condition ($M = 4.48$, $SE = .13$; see Figure 1 for observed means, and Figure 2 for Best Fit Model Comparisons). The best fit model also revealed that younger adults ($M = 4.64$, $SE = .16$) were more willing to help than older adults ($M = 4.32$, $SE = .15$) in the control condition, $B = -0.31$, $SE = 0.16$, $t(242.39) = 1.97$, 95% *CI* [−0.63, −0.00]. There was no age difference in willingness to help in the episodic simulation condition, $B = 0.21$, $SE = 0.16$, $t(236.87) = 1.34$, 95% *CI* [−0.10, 0.52]. Random effects for the best fit model were $\sigma^2 = 1.60$, ICC = 0.45, $\tau_{00\ id} = 1.12$, $\tau_{00\ Story\ Number} = 0.20$. Marginal and Conditional R^2 for the model were 0.072 and 0.493, respectively.

To further explore the interaction between condition and age on willingness to help, we tested the effect of condition in each age group separately. In younger adults, participant id (ICC = 0.34) and story number (ICC = 0.41), $\chi2(1) = 115.64$, $p < .001$, were found to add to the model and thus were retained as random effects. The effect of condition was found to increase willingness to help in younger adults, $B = 0.64$, $SE = 0.06$, $t(1517.31) = 10.02$, 95% *CI* [0.51, 0.76], such that willingness to help was higher following episodic simulation ($M = 5.25$, $SE = .15$) compared to the control condition ($M = 4.63$, $SE = .15$). Random effects for the model were $\sigma^2 = 1.58$, ICC = 0.42, $\tau_{00\ id} = .97$, $\tau_{00\ Story\ Number} = 0.18$. Marginal and Conditional R^2 for the model were 0.036 and 0.442, respectively.

In older adults, participant id (ICC = 0.36) and story number (ICC = 0.43), $\chi2(1) = 157.31$, $p < .001$, were found to add to the model and thus were retained as random effects. The effect of condition was found to increase willingness to help in older adults, $B = 1.16$,

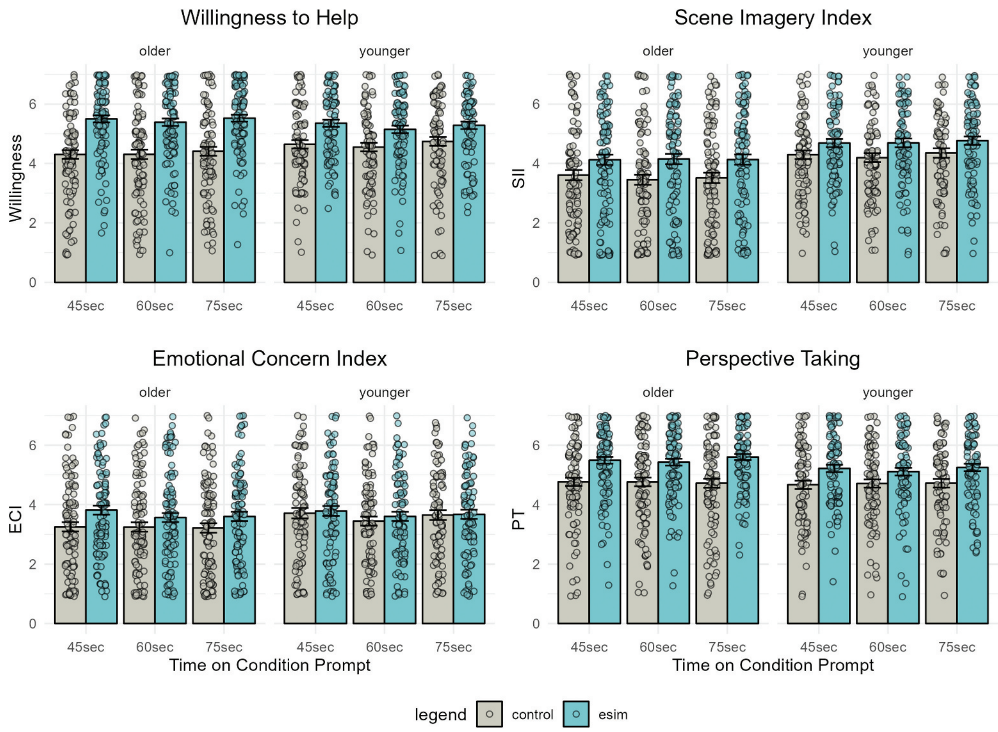

Figure 1. Observed means of participants' ratings across condition and time spent in condition. Note: Points are jittered to represent averaged for individual participants. Error bars represent standard error of the mean. The age split is presented for the purpose of comparison with the other variables.

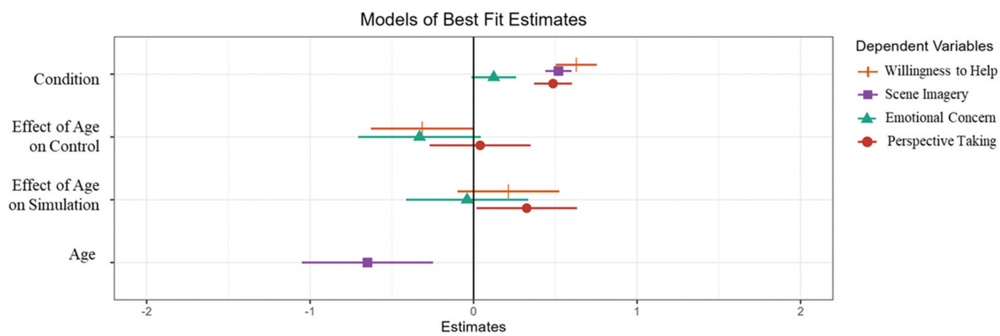

Figure 2. Best fit model estimates for dependent variables. Note: Error bars represent standard error of the mean. Condition contrasts compare episodic simulation to the control condition and age contrasts compare older to younger adults.

SE = 0.06, *t*(1783) = 19.47, 95% *CI* [1.04, 1.27], such that willingness to help was higher following episodic simulation (*M* = 5.48, *SE* = .16) compared to the control condition (*M* = 4.32, *SE* = .15). Random effects for the model were $\sigma^2 = 1.61$, ICC = 0.48, $\tau_{00\ id} = 1.26$, $\tau_{00\ Story\ Number} = 0.24$. Marginal and Conditional R^2 for the model were 0.097 and 0.533, respectively.

3.1.2. Scene vividness

The model predicting scene vividness included participant id (ICC = 0.59) and story number (ICC = 0.59), $\chi2(1) = 36.24$, $p < .001$, as random effects. Condition, $\chi2(1) = 156.42$, $p < .001$, and age, $\chi2(1) = 9.91$, $p = .002$ were found to improve model fit, and were retained for the best fit model. The timing manipulation and all other predictors did not improve model fit, *p's* > .111.

The best fit model for scene vividness revealed an effect of condition, $B = 0.52$, $SE = 0.04$, $t(3308.18) = 12.66$, 95% *CI* [0.44, 0.60], with participants reporting higher scene vividness following episodic simulation ($M = 4.43$, $SE = .11$) compared to the control condition ($M = 3.91$, $SE = .11$; see Figure 1 for observed means, and Figure 2 for Best Fit Model Comparisons). The best fit model also revealed an effect of age, $B = –0.65$, $SE = 0.20$, $t(206) = 3.17$, 95% *CI* [–1.05, –0.25], such that older adults ($M = 3.85$, $SE = .15$) reported lower scene vividness than younger adults ($M = 4.50$, $SE = .15$). Random effects for the best fit model were $\sigma^2 = 1.45$, ICC = 0.59, $\tau_{00\ id} = 2.08$, $\tau_{00\ Story\ Number} = 0.03$. Marginal and Conditional R^2 for the model were 0.046 and 0.612, respectively.

3.1.3. Emotional concern

The model predicting emotional concern included participant id (ICC = 0.42) and story number (ICC = 0.51), $\chi2(1) = 473.86$, $p < .001$, as random effects. Condition, $\chi2(1) = 35.70$, $p < .001$, and the condition by age interaction, $\chi2(1) = 9.47$, $p = .001$, were found to improve model fit and were retained for the best fit model. The timing manipulation and all other predictors did not improve model fit, *p's* > .331.

The best fit model for emotional concern revealed a trend for the effect of condition, $B = 0.12$, $SE = 0.07$, $t(3312.77) = 1.77$, 95% *CI* [–0.01, 0.26], with participants reporting numerically greater emotional concern following episodic simulation ($M = 3.68$, $SE = .17$) compared to the control condition ($M = 3.41$, $SE = .17$; see Figure 1 for observed means, and Figure 2 for Best Fit Model Comparisons). The interaction between condition and age also revealed a numerical difference between younger ($M = 3.57$, $SE = .20$) and older adults' ($M = 3.24$, $SE = .19$) emotional concern in the control condition, $B = –0.33$, $SE = 0.19$, $t(235.46) = 1.73$, 95% *CI* [–0.71, 0.04]; however, this difference did not reach significance. There was also no difference between younger ($M = 3.70$, $SE = .20$) and older adults' ($M = 3.66$, $SE = .19$) emotional concern in the episodic simulation condition, $B = –0.04$, $SE = 0.19$, $t(230.93) = 0.21$, 95% *CI* [–0.41, 0.33]. Random effects for the best fit model were $\sigma^2 = 1.90$, ICC = 0.51, $\tau_{00\ id} = 1.65$, $\tau_{00\ Story\ Number} = 0.33$. Marginal and Conditional R^2 for the model were 0.008 and 0.515, respectively.

To further explore the interaction between condition and age on emotional concern, we tested the effect of condition in each age group separately. In younger adults, participant id (ICC = 0.40) and story number (ICC = 0.48), $\chi2(1) = 162.49$, $p < .001$, were found to add to the model and thus were retained as random effects. The effect of condition did not increase emotional concern in younger adults, $B = 0.11$, $SE = 0.07$, $t(1515) = 1.61$, 95% *CI* [–0.03, 0.25]. Random effects for the model were $\sigma^2 = 1.95$, ICC = 0.48, $\tau_{00\ id} = 1.50$, $\tau_{00\ Story\ Number} = 0.28$. Marginal and Conditional R^2 for the model were 0.001 and 0.478, respectively.

In older adults, participant id (ICC = 0.44) and story number (ICC = 0.54), $\chi2(1) = 294.58$, $p < .001$, were found to add to the model and thus were retained as random effects. The effect of condition increased emotional concern in older adults, $B = 0.41$, $SE = 0.06$, *t*(1782) = 6.57, 95% *CI* [0.29, 0.53]. Random effects for the model were $\sigma^2 = 1.84$, ICC = 0.54, $\tau_{00\ id} = 1.79$, $\tau_{00\ Story\ Number} = 0.40$. Marginal and Conditional R^2 for the model were 0.010 and 0.548, respectively. Thus, the condition by age interaction in the main model is due to older (but not younger) adults exhibiting an increase in emotional concern following episodic simulation.

3.1.4. Perspective-taking

The model predicting perspective taking included participant id (ICC = 0.40) and story number (ICC = 0.47), $\chi 2(1) = 322.29$, $p < .001$, as random effects. Condition, $\chi 2(1) = 248.17$, $p < .001$, and the condition by age interaction, $\chi 2(1) = 12.56$, $p = .001$ were found to improve model fit, and were retained for the best fit model. The timing manipulation and all other predictors did not improve model fit, *p's* > .214.

The best fit model for perspective taking revealed an effect of condition, *B* = 0.49, *SE* = 0.06, *t*(3315) = 8.22, 95% *CI* [0.37, 0.60], with participants reporting greater perspective taking following episodic simulation (*M* = 5.35, *SE* = .13) compared to the control condition (*M* = 4.72, *SE* = .13; see Figure 1 for observed means, and Figure 2 for Best Fit Model Comparisons). The interaction between condition and age was found to be a result of younger adults (*M* = 5.19, *SE* = .15) exhibiting lower ratings of perspective taking than older adults (*M* = 5.55, *SE* = .15) in the episodic simulation condition, *B* = 0.32, *SE* = 0.16, *t*(233) = 2.07, 95% *CI* [0.02, 0.63]. There was no difference in younger (*M* = 4.70, *SE* = .15) and older adults' (*M* = 4.74, *SE* = .15) perspective taking ratings in the control condition, *B* = 0.04, *SE* = 0.15, *t*(237.8) = 0.25, 95% *CI* [−0.27, 0.35].

To fully explore the interaction between condition and age on perspective taking, we tested the effect of condition in each age group separately. In younger adults, participant id (ICC = 0.40) and story number (ICC = 0.46), $\chi 2(1) = 128.91$, $p < .001$, were found to add to the model and thus retained as random effects. The effect of condition increased perspective taking, *B* = 0.49, *SE* = 0.06, *t*(1515) = 8.20, 95% *CI* [0.37, 0.61], such that perspective taking was higher after episodic simulation (*M* = 5.19, *SE* = .15) compared to the control condition (*M* = 4.70, *SE* = .15). Random effects for the model were $\sigma^2 = 1.38$, ICC = 0.47, $\tau_{00\ id} = 1.07$, $\tau_{00\ Story\ Number} = 0.17$. Marginal and Conditional R^2 for the model were 0.022 and 0.484, respectively.

In older adults, participant id (ICC = 0.40) and story number (ICC = 0.47), $\chi 2(1) = 161.56$, $p < .001$, were found to add to the model and thus were retained as random effects. The effect of condition increased perspective taking in older adults, *B* = 0.77, *SE* = 0.05, *t*(1783) = 14.30, 95% *CI* [0.67, 0.88], such that perspective taking was higher after episodic simulation (*M* = 5.52, *SE* = .15), compared to the control condition (*M* = 4.74, *SE* = .15). Random effects for the model were $\sigma^2 = 1.36$, ICC = 0.50, $\tau_{00\ id} = 1.15$, $\tau_{00\ Story\ Number} = 0.19$. Marginal and Conditional R^2 for the model were 0.052 and 0.522, respectively. Thus, the condition by age interaction in the main model is due to younger adults exhibiting lower levels of perspective taking after episodic simulation. Nevertheless, episodic simulation increased perspective taking within each age group relative to the control condition.

3.2. Effects of time manipulation on details produced

3.2.1. Total details produced

The model predicting the total number of details produced on episodic simulation trials included participant id (ICC = 0.95) and story number (ICC = 0.04), $\chi 2(1) = 42.56$, $p < .001$, as random effects. Only time spent imagining was found to add to the model and thus retained for the best fit model, $\chi2(1) = 40.56$, $p < .001$. Neither age nor the interaction between age and time spent imagining improved model fit, *p's* > .080.

The best fit model for the number of details produced revealed a significant difference between details produced after imagining for 60 seconds, $B = 0.18$, $SE = 0.05$, $t(1598) = 3.43$, 95% *CI* [0.08, 0.29]) and 75 seconds ($B = 0.34$, $SE = 0.05$, $t(1597) = 6.43$, 95% *CI* [0.24, 0.45]). Further probing of the model revealed that the contrast between the 60 and 75-second timing conditions was also significant, t (1601) = 2.99, $p = .008$, suggesting that the number of details produced increased in line with time spent imagining (see Figure 3 for observed means[1]).

3.2.2. Internal and external details produced

The model predicting the number of internal details produced (on episodic simulation trials only) included participant id (ICC = 0.49) and story number (ICC = 0.52), $\chi2(1) = 85.91$, $p < .001$, as random effects. The time spent imagining was found to add to the model and thus retained for the best fit model, $\chi2(1) = 23.23$, $p < .001$. While younger adults produced numerically more internal details, neither age nor the other predictors improved model fit, *p's* > .212 (See Figure 4 for observed means).

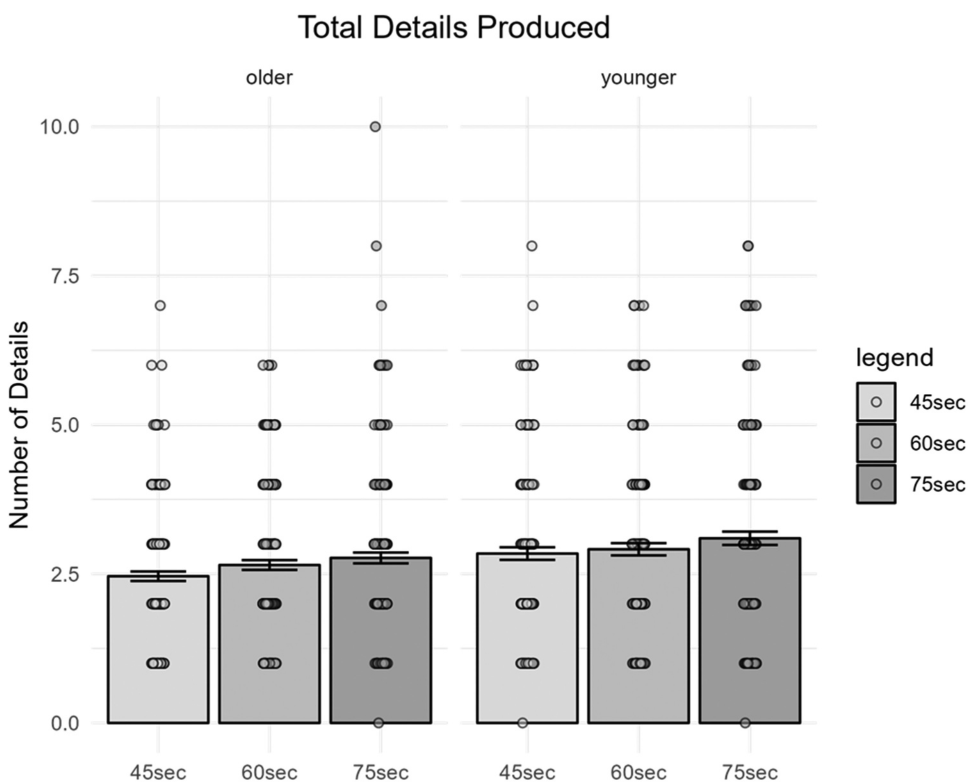

Figure 3. Total number of details produced on episodic simulation trials. Note: Points are jittered to represent the average for individual participants. Error bars represent standard error of the mean. While there was no effect or interaction with age, the age split is presented for the purpose of comparison with variables that demonstrated an effect of age.

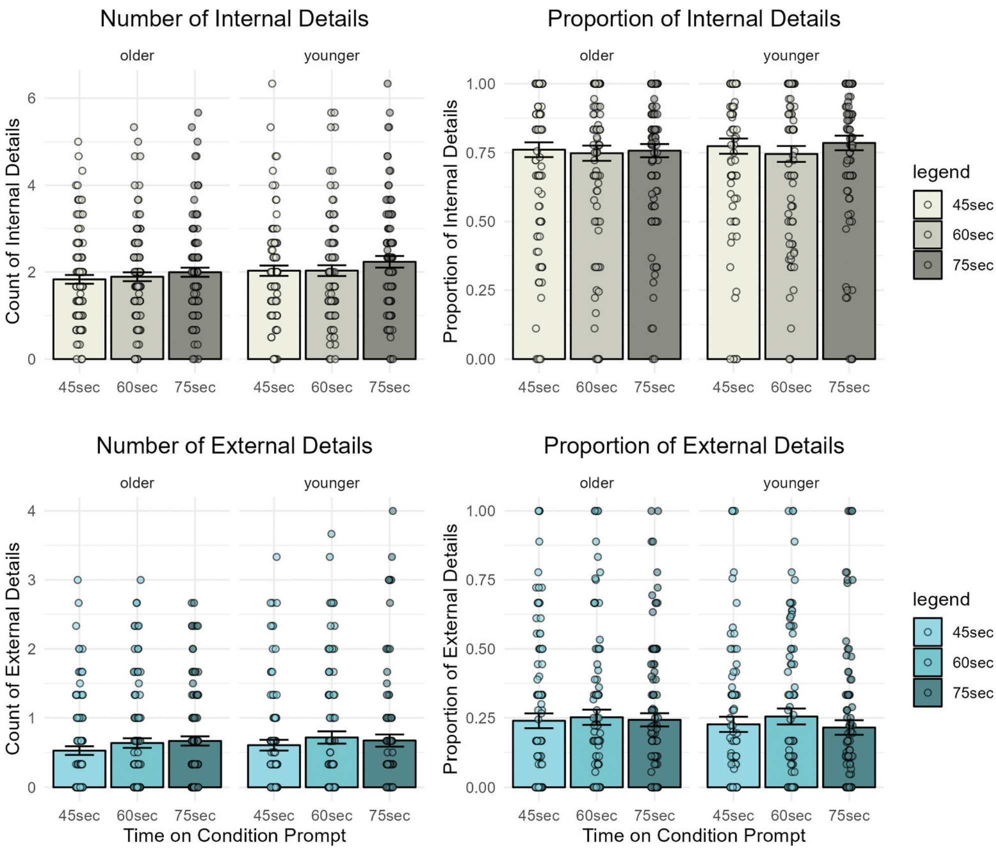

Figure 4. Internal and external details produced on episodic simulation trials as average count and proportion. Note: Points are jittered to represent the average for individual participants. Error bars represent standard error of the mean. While there was no effect or interaction with age, the age split is presented for the purpose of comparison with variables that demonstrated an effect of age.

The best fit model for the number of internal details produced revealed a significant difference between details produced after imagining for 75 seconds compared to imagining for 45 seconds, $B = 0.28$, $SE = 0.06$, $t(1604) = 4.81$, 95% CI [0.16, 0.39]. There was also a trend toward more internal details produced after 60 seconds relative to 45 seconds, $B = 0.11$, $SE = 0.06$, $t(1604) = 1.86$, 95% CI [–0.01, 0.22].

In terms of external details, the initial model included participant id (ICC = 0.38) and story number (ICC = 0.40), $\chi2(1) = 29.60$, $p < .001$, as random effects. No fixed predictors improved model fit, $p's > .161$.

3.2.3. Proportion of details

We also looked at the proportion of internal and external details produced (i.e., divided by the total number of both types of detail), as this measure is thought to take individual differences in verbosity into account (Levine et al., 2002). The model predicting the proportion of internal details produced included participant id (ICC = 0.36) and story number (ICC = 0.39), $\chi2(1) = 41.19$, $p < .001$, as random effects. None of the fixed factors improved model fit, p's > .290. In terms of the proportion of external details, the initial

Table 1. Within-subject correlations between objective and subjective measures of scene vividness.

Time on Prompt	45 Seconds		60 Seconds		75 Seconds	
Objective Measure	Younger	Older	Younger	Older	Younger	Older
Count of internal details	0.19	0.25*	0.17	0.04	0.13	0.09
Proportion of internal details	0.23*	0.25*	0.09	0.08	0.11	0.029
Count of external details	−0.17	−0.22*	0.07	0.008	−0.14	−0.02
Proportion of external details	−0.23*	−0.25*	−0.09	−0.08	−0.11	−0.03

Correlation values reflect the within-subject correlation (r_{rm}) between scene vividness ratings and details produced. Bonferroni correction was used to account for multiple comparisons. Significant correlations are noted by * ($p < .002$).

model included participant id (ICC = 0.36) and story number, $\chi2(1) = 41.19$, $p < .001$; ICC = 0.39, as random effects. No fixed predictors improved model fit, p's > .290.

3.3. Correlation between objective and subjective measures of scene vividness

To explore whether the number and proportion of details produced (here used as a proxy measure of objective scene vividness) were associated with younger and older adults' subjective ratings of scene vividness, we conducted repeated measures correlations using the "rmcorr" package (Bakdash & Marusich, 2017). Because time was found to influence the number of internal details produced, correlational analyses were conducted within each time condition separately. Alpha level was Bonferroni adjusted ($p < .002$) to correct for the 24 tests performed. We found relationships between objective and subjective measures of scene vividness when participants spent 45 seconds on the condition prompt (see Table 1 for r_{rm} coefficients). In younger adults, only the proportions of details produced were significantly correlated to participants' subjective scene vividness ratings. In older adults, both the proportions and numbers of details produced were related to participants' subjective scene vividness ratings.

4. Discussion

The current study explored whether time spent engaging in episodic simulation affects willingness to help and various phenomenological experiences in older and younger adults, and whether this also affects the number of internal and external details produced. Our results demonstrate that episodic simulation increases participants' willingness to help, scene vividness, and perspective taking relative to a semantic control condition, regardless of the time spent simulating future helping scenarios. Simulation also increased emotional concern in older (but not younger) adults. Perhaps unsurprisingly, our results also demonstrate that time spent imagining influenced the number of internal, episodic-like details produced, such that longer time spent imagining resulted in the production of more internal details. However, it is interesting to note that timing did not significantly affect the number of external details produced or the proportion of internal details.

Our finding that episodic simulation increased willingness to help relative to the semantic baseline condition for both younger and older adults is consistent with recent research examining episodic simulation of helping behavior across the lifespan (Gaesser & Schacter, 2014; Gaesser et al., 2017; Ryan, O'Connor, et al., 2023; Ryan, Smitko, et al., 2023). We also extend these findings to show that the effect of episodic simulation of such helping behaviors is a relatively fast process that is unaffected by the current time manipulation. Moreover, the lack of interaction between participant age and time spent imagining on willingness to help suggests that older adults can engage in episodic simulation of helping behavior to a similar degree as younger adults.

In terms of age differences, the present study found that older adults reported lower scene vividness ratings than younger adults. While some work examining future thinking across the lifespan has reported higher vividness ratings in older adults (Jarvis & Miller, 2017; Robin & Moscovitch, 2014), these findings were based on participants using a single scale of "visual vividness." Conversely, much of the research examining episodic simulation of helping behaviors has used a composite scene vividness variable that encompasses both scene detail and coherence (Gaesser & Schacter, 2014; Gaesser et al., 2017; Ryan, O'Connor, et al., 2023; Ryan, Smitko, et al., 2023). While some of this work has failed to find age differences in the scene vividness composite (Gaesser et al., 2017, supplemental materials; Ryan, O'Connor, et al., 2023, supplemental materials), these studies used ANOVAs, and therefore report participant-wise averages. Indeed, research using mixed effect modeling, which accounts for trial-wise variability, has shown that older adults report less vividness than younger adults (Ryan, Smitko, et al., 2023), which we replicate in the current study.

We also found that the effect of condition differentially influenced emotional concern and perspective taking in younger and older participants. Specifically, episodic simulation increased emotional concern in older, but not younger adults, and while both age cohorts exhibited an increase in perspective taking following episodic simulation, older adults exhibited a greater change relative to the control condition. Such findings likely reflect age-related increases in empathy and prosociality (Carstensen et al., 2006; Mayr & Freund, 2020), and may also point to age differences in the cognitive mechanisms used to simulate future helping behaviors. Indeed, previous research (Ryan, Smitko, et al., 2023) has shown that younger adults' scene vividness and perspective taking mediates the relationship between one's previous experience and willingness to help in imagined future scenarios, whereas only perspective taking mediated the relationship in older adults. Taken together these findings suggest that older adults' future thoughts may contain more concern and consideration about the thoughts and feelings of the person in need.

Contrary to our expectations, time spent imagining did not influence younger or older adults' subjective experiences when simulating future helping behaviors, suggesting that imagining future helping scenarios is a reasonably fast process. Relatedly, when time spent imagining was limited to 45 seconds, we found a relationship between the proportion of details produced and participants' subjective scene vividness ratings. However, detail counts only related to scene vividness in older adults. Previous research has shown that higher similarity between imagined and lived personal experiences is positively related to participants' subjective experience of their imagined scenarios (Ryan, Smitko, et al., 2023). Indeed, familiar events are clearer than those set in unfamiliar settings (Arnold et al., 2011), and thus because the current imagined scenarios involved solving everyday social problems, it is likely that scenes were relatively easy for participants to imagine. Given that semantic memory is relatively stable with age (Umanath & Marsh, 2014), and that such semantic knowledge can be used to scaffold imagined events in one's mind (Irish et al., 2012), the common scenarios used in the current study may partially account for the lack of differences across age and time spent imagining. Future research should examine how factors such as similarity and familiarity influence younger and older adults' subjective and objective experiences when time spent imagining is limited.

To the best of our knowledge, this is one of the first studies to explore the impact of time on older adults' simulation of future events. Previous work that has explored episodic simulation in younger and older adults has allowed participants to describe their imagined future events without time constraints (Gaesser et al., 2017; Ryan, Smitko, et al., 2023) or limited all participants to the same amount of time (Addis et al., 2008; Ryan, O'Connor, et al., 2023). Moreover, research examining episodic simulation in younger and older adults does not always report both phenomenological experiences (Madore & Schacter, 2014) and internal details (Gaesser et al., 2017) and those that do, do not necessarily report internal details as both an average count and proportion (Ryan, O'Connor, et al., 2023). Critically, our findings point to a difference in the effect of time spent imagining on the number of internal details produced and one's own phenomenological experience of the imagined event (i.e., scene vividness, emotional concern, and perspective taking). Specifically, we demonstrate that scene vividness, emotional concern, and perspective taking were unaffected by the time spent imagining, whereas the number of internal details produced increased with more time.

Recent research has examined the reliability and validity of the autobiographical interview as a means for scoring episodic memory (Lockrow et al., 2023). Importantly, this work demonstrated that accounting for participants' overall verbal output (i.e., total number of details produced) may be a more stable and "appropriate" means of examining trait-level autobiographical memory abilities than comparing detail counts alone. As discussed, when internal details were represented as a proportion of total details in the current study, the effect of time was eliminated. Moreover, accounting for total details in the current study allowed for better alignment with participants' subjective phenomenological experiences, such that detail proportions were related to subjective scene vividness in both younger and older adults. Thus, in line with the Lockrow et al. (2023) findings, our work suggests that the proportion of internal details may be more robust to extenuating factors, such as verbosity and time spent on task. However, future research should examine this in more detail.

Another issue to consider is that younger and older adults have different communicative goals (James et al., 1998) which may be affected by the topics individuals are asked to describe (Trunk & Abrams, 2009). For instance, older adults tend to be more prosocial (Mayr & Freund, 2020) which may influence their performance when they preform tasks that focus on the greater good (Carstensen et al., 2006), such as imagining helping a person in need. Increased prosocial attitudes and activities may also mean that older adults have personal experiences they can reference when they imagine helping others. According to the *constructive episodic simulation hypothesis*, we recombine details from our past experiences when generating new scenarios (Schacter & Addis, 2007). Thus, if older adults are engaged in more prosocial activities, they may have more experiences on which to draw when imagining helping others in need. Relatedly, older adults selectively engage with tasks that they consider to be meaningful (Hess, 2014; Hess & Ennis, 2012). Taken together, framing future scenarios as events that older participants are personally involved with, in a domain that they care about and have experience with may not only encourage engagement with the task itself, but may also bolster older participants' use of episodic details. Future research should aim to clarify the importance of these factors.

4.1. Limitations & future directions

Although the current findings are compelling, it is important to address a number of limitations that should be addressed in future research. Firstly, the present study was conducted online and older adults who take part in online research may be higher functioning and more computer savvy than those who typically participate in the lab (Merz et al., 2022). Relatedly, due to the nature of online testing, the time manipulations used in the current study were 45, 60, and 75 seconds, to allow participants enough time to type their responses. The current results suggest that simulating future events is a reasonably fast process, but it may also be that the current time manipulation was not different enough to be influenced by age-related differences in processing speed (Salthouse, 2010) and thus have an appreciable effect on participants' subjective and objective experience of imagined future scenarios. Future research should include even shorter durations and larger intervals between durations to further explore whether timing has an effect. Finally, the average age of older adults in the current sample was 66.04 and thus, may represent a younger cohort of older adults, who may not yet be experiencing age-related cognitive decline.

5. Conclusion

In conclusion, the present study suggests that time spent engaging in episodic simulation of helping behavior does not influence willingness to help or phenomenological experiences in younger and older adults, suggesting that episodic simulation of such social problems is a relatively fast process. Moreover, although time spent imagining was found to influence the average number of internal details produced, accounting for the total number of details provided in that time nullifies the effect of time, suggesting that it is important to account for the effects of verbosity and that proportional representations of details produced may be a more appropriate way to assess episodic memory and simulation abilities (Levine et al., 2002; Lockrow et al., 2023). Taken together, the present findings highlight the importance of collecting phenomenological experience when assessing episodic simulation abilities across the lifespan and considering the production of internal details as both the number and proportion of details produced.

Note

1. Means did not appear to be at floor, as the number of internal and external details produced by younger and older adults was significantly different from zero across all timings. Internal details: $younger_{45}$, t (272) = 23.54, $p < .001$, $older_{45}$, t (328) = 25.90, $p < .001$, $younger_{60}$, t (278) = 24.46, $p < .001$, $older_{60}$, t (326) = 25.80, $p < .001$, $younger_{75}$, t (278) = 24.04, $p < .001$, $older_{75}$, t (327) = 26.71, $p < .001$.External details: $younger_{45}$, t (272) = 9.70, $p < .001$, $older_{45}$, t (327) = 11.23, $p < .001$, $younger_{60}$, t (277) = 11.10, $p < .001$, $older_{60}$, t (326) = 11.86, $p < .001$, $younger_{75}$, t (278) = 10.16, $p < .001$, $older_{75}$, t (327) = 12.57, $p < .001$.

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Data availability statement

The data that support the findings of this study are available from the corresponding author, ADR upon reasonable request.

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