Mechanisms of episodic simulation of helping behaviour in younger and older adults

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Abstract

The ability to recall the past (i.e., episodic memory) and simulate hypothetical events (i.e., episodic simulation) are intrinsically linked, and individuals with diminished episodic memory abilities show similar deficits when imagining potential future events. For instance, age-related declines in episodic memory are mirrored in older adults' simulations of future events, such that older adults produce fewer episodic details, and more semantic information, than younger adults when both remembering the past and imagining the future. Despite such deficits, recent research suggests that older adults can successfully imagine future scenarios in which they help people in need; however, these findings are limited, and the underlying mechanisms remain unclear.

The present thesis examines whether episodic simulation of future helping behaviours differs between younger and older adults under several conditions. Chapter 2 demonstrates that episodic simulation of helping behaviour increases younger and older adults' willingness to help even in the highly novel scenarios posed by the pandemic. Participants relied more on non-episodic details when imagining COVID-related scenarios for which they had limited similar experiences. Relatedly, in Chapter 3, both episodic simulation and similarity to one's personal experiences increase willingness to help and phenomenological experiences, but the mechanisms differ between younger and older adults. Scene vividness and perspective-taking mediated the relationship between situation similarity and willingness to help in younger adults, but only perspective-taking had an indirect effect in older adults. Finally, Chapter 4 suggests that time-spent-imagining does not affect older adults' ability to simulate future helping behaviours. However, time-spent-imagining did affect the number of internal details produced, but the proportion of internal details (correcting for total details produced) was not affected by time. As such, the often-used metric of a *count* of episodic details alone may not be the best measure to assess episodic simulation abilities in younger and older adults.

Taken together, the present studies suggest that episodic simulation of helping similarly increases younger and older adults' willingness to help, but the underlying mechanisms likely differ across the lifespan. Additionally, both subjective and objective measures of simulated events must be examined to accurately assess simulation abilities across the lifespan.

Keywords: *episodic simulation, aging, scene imagery, perspective taking, helping behaviour*

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Table of Contents

List of Tables

List of Figures

Chapter 1: General Introduction

Imagining hypothetical scenarios (i.e., episodic simulation) is crucial in our everyday lives as it enables us to weigh our options as we plan for the future, make decisions, and solve problems (Atance & O'Neill, 2001; Schacter & Addis, 2007). Research suggests that episodic memory is an integral component of our ability to generate these hypothetical scenarios and the reconstructive process that gives rise to episodic memory may also be responsible for episodic simulation (Schacter & Addis, 2007). Given that episodic memory and simulation both seem to rely on the same neural network (Benoit & Schacter, 2015), which is affected by age (Spreng & Grady, 2010; Spreng, Mar, & Kim, 2009; Buckner & Carrol, 2007), it is perhaps unsurprising that age-related deficits noted in episodic memory paradigms have also been found in episodic simulation tasks (Addis et al., 2008). However, a growing body of research suggests that older adults show evidence of successful simulation under certain conditions, such as imagining helping a person in need (Gaesser et al., 2017; Sawczak et al., 2019). The present thesis examines how episodic simulation of helping differs between younger and older adults under various conditions to provide a better understanding of the cognitive mechanisms that enable episodic simulation across the lifespan.

Episodic memory as a constructive process

Episodic memory is characterized by the ability to encode, store, and consciously recall personal experiences from our everyday lives (Nyberg & Tulving, 1996; Tulving, 1983; 2002). In contrast to semantic memory, which represents general knowledge about the world devoid of information about when/where that information was acquired (Nyberg & Tulving, 1996; Tulving, 1983; 2002), episodic memories contain rich details about the time and space in which an event occurred, as well as specific details about what occurred during the event itself (Tulving, 1983, 2002). Subjectively, when individuals engage in episodic recall, they often experience visual imagery, feelings of familiarity, and a sense of presence, all of which coalesce into the feeling that they are re-living the past event (Rubin et al., 2003; Tulving, 2002; Wagner et al., 2005). For example, consider the last family event you attended. You can likely recall important details such as where and when the event took place, who attended the event, and what the attendees said and did during your time together. This form of mental time-travel allows us to learn from and consider experiences in our personal pasts and thus, is integral for our day-to-day functioning.

Despite the sensation of re-living the past provided by episodic memory, representations of these past personal experiences are not simply stored and recalled as exact copies of our lived experiences. Instead, episodic memory is considered to be a reconstructive process in which one flexibly binds together informational components of an event to mentally re-experience the event itself (Pollio & Foote, 1971; Jacobs & Nadel, 1998; Conway & Pleydell-Pearce, 2000; Mather, 2007). Certainly, bringing the components of a memory together as needed is more computationally efficient and pragmatic than storing a representation of each event as its own unique memory, and given than many of our lived experiences can occur in the same location (i.e., one's home or office), it is unlikely we store such representations multiple times (Schacter & Addis, 2007; Schacter, 2001). For instance, this process of drawing together components about an event and constructing coherent scenes (Hassabis & Maguire, 2007) allows information about an often-visited location to act as the backdrop for multiple events without 'wasting' storage by remembering the same information multiple times.

Episodic simulation: An adaptive function of episodic memory

The ability to flexibly recombine information may also represent an adaptive function that allows one to generate hypothetical scenarios (i.e., episodic simulation). For instance, when recalling a negative personal experience such as a break-up, one may consider hypothetical alternatives that would have produced a more favourable outcome for the relationship (Roese, 1997; De Brigard & Parikh, 2018). Indeed, future scenes may be mentally constructed via the same basic processes used when remembering a lived experience (Hassabis & Maguire, 2007) and projecting oneself into said hypothetical scenarios may enable one to consider potential future behaviours (Bucker & Carroll, 2007). As such, reflecting on our lived experiences, likely enables us to anticipate and shape our future behaviours so that we can avoid situations that bring about negative outcomes (Roese, 1997; Suddendorf & Corballis, 2007). This concept has given rise to the *constructive episodic simulation hypothesis*, which posits that we flexibly recombine information from our past experiences to generate counterfactual events (i.e., what one should have or could have done) and episodic future thinking (i.e., what one imagines doing in future events; Schacter et al., 2015; Schacter & Addis, 2007, 2020).

Neural evidence of a connection between episodic memory and simulation

Although a considerable amount of research into episodic future thinking has been produced over the last 15 years, evidence for a link between episodic memory and episodic simulation has been around for much longer. Indeed, some of the early evidence for a connection between episodic memory and imagining hypothetical future events comes from individuals with damaged or dysfunctional frontal regions of the brain and amnesic patients (Ingvar, 1985; Klein et al., 2002). For instance, clinical evidence from patients with lesioned or otherwise dysfunctional frontal cortices suggests that such patients have blunted foresight in the form of reduced plans for the future and a deficiency in understanding future consequences compared to matched controls (Ingvar, 1985). Relatedly, case studies from amnesic patients (with damage to the medial temporal lobes [MTL]) demonstrate that many of the deficits noted in episodic memory can also be seen when asking these patients to simulate hypothetical events (Klein et al., 2002; Hassabis et al., 2007). For instance, a case study examining a patient with profound deficits (compared to controls) on free recall and episodic memory tasks demonstrated that the patient performed equally poorly when asked to describe potential future events (Klein et al., 2002), suggesting a shared neurocognitive process had been disrupted.

Individuals with hippocampal amnesia also exhibit considerable subjective and objective impairments when imagining atemporal hypothetical experiences (Hassabis et al., 2007). For example, when asked to imagine new experiences related to verbal cues (e.g., beach), patients with bilateral hippocampal damage were only able to generate fragmented bits of information. Moreover, the information generated by these patients seemed to lack spatial details, suggesting that they were unable to bind the disparate elements together to form a coherent scene (Hassabis et al., 2007). Relatedly, research demonstrates that patients with MTL damage are able to generate narratives about pictures they are presented with, but they exhibit marked deficits when constructing narratives about past and future events (Race et al., 2011). Notably, these researchers found a positive correlation between episodic memory and future narrative performance, but no such relationship between episodic memory and picture description narratives, suggesting that the link between episodic memory and episodic simulation is not simply due to patients' story-telling abilities (Race et al., 2011). Through a model of dysfunction, such lesion studies establish a link between episodic memory and simulation and begin to identify brain regions that are important for these processes.

Neuroimaging research in healthy individuals also suggests that there is considerable overlap in the neural underpinnings responsible for remembering the past and imagining the future. In these studies, participants are often given a noun as a cue word (e.g., shoe) or a triad of cue words (e.g., person, place, and thing) and asked to either remember a previous event involving that/those concept(s) or to simulate a possible future event (Addis et al., 2008; Szpunar & McDermott, 2008; Szpunar, 2010). These studies have consistently shown that both episodic retrieval and simulation result in a similar pattern of activation across a 'core network' of regions (including the medial prefrontal cortex, MTL, posterior cingulate, posterior midline region near the precuneus, and parahippocampal gyrus; Spreng & Grady, 2010; Schacter et al., 2015; Benoit & Schacter, 2015). This collection of regions is often referred to as the *default mode network* and is known to be active when individuals are engaged in internally directed thought, such as during theory of mind and autobiographical recall (Spreng, Mar, & Kim, 2009; Buckner & Carrol, 2007). Activity in some of these key regions is said to be 'indistinguishable' when contrasting episodic memory and simulation tasks (Szpunar et al., 2007), again suggesting an overlap in the neurocognitive processes involved in remembering the past and imagining the future.

Episodic memory and simulation in older adults

The brain regions implicated in episodic memory and simulation are known to be particularly affected by age (Persson et al., 2006; van Petten et al., 2004), and further evidence for the connection between episodic memory and episodic future thought comes from work with older adults. Compared to younger age cohorts, older adults exhibit impaired episodic memory (as measured by free recall and recognition tasks), but relatively intact semantic memory (as measured by tasks such as picture-naming and vocabulary tests; Nyberg & Tulving, 1996). Indeed, there is considerable support for a dissociation between episodic and semantic memory performance in younger and older adults and semantic memory appears to be stable compared to the age-related decline noted in episodic memory (Piolino et al., 2002).

One method for examining the episodic and semantic content of memory relies on the Autobiographical Interview (AI), a scoring protocol that categorizes the details produced by participants during free recall (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). The AI allows researchers to systematically break down open-ended responses on free recall tasks to allow for a more objective measure of memory content. Details are coded as being internal if they are central to the event being remembered (and thus more episodic-like), or external, if they consist of extraneous and semantic information unrelated to the event (Levine et al., 2002). Importantly, research using this reliable (Lockrow et al., 2023) scoring tool provides further evidence that there is an age-related decline associated with episodic memory. For instance, when asked to recall personal life events, younger adults tend to produce more internal details reflecting the location, happenings, and thoughts that occurred during the events, while older adults produce more unrelated details devoid of temporal and spatial relevance (Levine et al., 2002; Greene & Naveh-Benjamin, 2023).

Using internal and external details to characterize older and younger adults' simulations of future events yields a similar pattern of results (Schacter, Gaesser, & Addis, 2013). Specifically, when older adults are asked to recall past events or imagine future events, they produce fewer internal and more external details than younger adults (Addis et al., 2007; 2010). Further, both younger and older adults exhibit a trade-off in their use of internal and external/semantic details, such that (within an individual) there is a negative relation between the number of internal and external/semantic details produced when remembering the past and imagining the future (Devitt et al., 2017). This relation has been found to be more pronounced in older adults, which is thought to reflect their declining episodic memory abilities which they compensate for with more semantic information. While some of this trade-off may be due to age differences in narrative style, insofar as older adults also use fewer internal and more external details to describe photos of scenes that are right in front of them, age differences in the number of internal details produced persists even after controlling for this picture-description task (Gaesser et al., 2011). This suggests that older adults' reduced production of internal details during memory and imagination is not simply due to age differences in narrative style but to shared neurocognitive processes between memory and imagination.

Episodic deficits in problem-solving tasks

Older adults' increased use of external rather than internal details when imagining future events has also been found to extend to higher-order cognitive processes, such as problem-solving tasks (Sheldon et al., 2011; Vandermorris et al., 2013). When asked to generate solutions to problems with a predetermined end (i.e., means-end problem solving) older adults were once again found to produce fewer internal and more external details than younger adults (Sheldon et al., 2011; Vandermorris et al., 2013). Critically, effective problem solving has been shown to rely on episodic processes over and above the contribution of executive functions (Vandermorris et al., 2013). Indeed, while there is a positive correlation between the number of internal details produced on memory, imagined, and problem-solving tasks, and the number of *appropriate* steps produced to solve hypothetical problems, age has been shown to share a negative relationship with all of these factors (Madore & Schacter, 2014).

Nevertheless, some problem-solving paradigms suggest that older adults can successfully simulate hypothetical scenarios, particularly those involving social situations (Crawford & Channon, 2002; Peters et al., 2019). Indeed, while older adults produce fewer means to solve social problems, research suggests that the solutions they produce are judged as better in terms of practicality and social appropriateness (Crawford & Channon, 2002), which may reflect their accumulated life experience and semantic knowledge (Blanchard-Fields et al., 2007).

Relatedly, a growing body of research demonstrates that asking individuals to solve social problems by imagining themselves helping a person in need can increase younger and older adults' willingness to help to a similar extent (relative to a control task; Gaesser et al., 2017; Sawczak et al., 2019). A 2017 study by Gaesser et al., presented younger and older adults with a series of brief, one-line problems depicting a person in need of help (e.g., This person is locked out of their house). After imagining themselves helping the person in need, both younger and older adults showed a cognitive shift evidenced by an increase in their willingness to help compared to a no-helping condition. However, researchers found that controlling for older adults' higher levels of emotional concern for the person in need eliminated the effect of episodic simulation in older adults' willingness to help ratings, suggesting that their increased willingness to help may have been driven by concern for others rather than successful simulation (Gaesser et al., 2017). Another study replicated the finding that younger and older adults' willingness to help can be increased by simulating future helping scenarios; however, this study reported an increase in emotional concern in younger, but not older adults (Sawczak et al., 2019). These conflicting results underscore the need for further examination of the mechanisms underlying episodic simulation of helping behaviour and how they may differ between younger and older adults.

Overview of the present studies

The studies presented in this thesis aimed to further our understanding of episodic simulation of helping in younger and older adults by varying the nature of the scenarios or the time provided for simulation. Specifically, I examined the extent to which episodic simulation increases willingness to help in both younger and older adults when given 1) completely novel scenarios related to the COVID-19 pandemic, 2) everyday scenarios that are more or less familiar to younger and older adults, and 3) varying amounts of time to simulate the helping scenario. I also examined how these factors affected people's phenomenological experiences of the imagined events (i.e., ratings of scene imagery, emotional concern, and perspective taking) and whether simulation-related increases in willingness to help were mediated via different phenomenological mechanisms in younger and older adults. Below, I provide a brief overview of each chapter.

In Chapter 2, I test whether episodic simulation increased willingness to help in younger and older adults in the unprecedented scenarios posed by the COVID-19 pandemic (i.e., having a housemate who refuses to adhere to social distancing guidelines). Across three studies, both younger and older adults exhibited an increase in willingness to help following episodic simulation, compared to a semantic control condition in which they judged the style and source of the story. Moreover, I found that episodic simulation also increases scene imagery, theory of mind, and emotional concern. Previous work suggests that these phenomenological experiences serve as mechanisms via which episodic simulation increases one's willingness to help others (Gaesser & Schacter, 2014; Gaesser et al., 2017; Sawczak et al., 2019). Importantly, the lack of age effect across these studies suggests that episodic simulation is relatively preserved in older adults, at least within this paradigm.

Chapter 2 also shows that younger and older adults produce fewer internal, episodic-like details when imagining novel COVID-related scenarios, suggesting that participants may rely more on external details (such as semantic information) to imagine unfamiliar future helping scenarios. Indeed, on trials where participants were asked to imagine future helping scenarios, there was an indirect effect of story type operating through internal details produced, such that COVID-related scenarios were linked to less internal details and in turn, a lower willingness to help relative to the everyday stories. Taken together this chapter replicates previous findings that episodic simulation can increase willingness to help in both younger and older adults and highlights the need to rely on external/semantic details when imagining highly novel events, such as those encountered during the early days of the pandemic.

Chapter 3 builds on this finding about novel or unfamiliar scenarios by examining how being asked to imagine situations similar to one's personal experiences may influence episodic simulation in younger and older adults. As discussed, individuals draw on their previous experiences (i.e., episodic memory) to generate future scenarios; however, research examining episodic simulation of unfamiliar events often asks participants to generate largely hypothetical scenarios which may be especially unlikely for older adults (e.g., climbing Mount Everest; Arnold, McDermott, & Szpunar, 2011). The research presented in Chapter 3 first used a pilot study to identify story content that was most/least familiar to younger and older adults. These young-familiar and older-familiar scenarios were then used to examine how one's previous experience with a problem scenario (measured as participants' situation similarity ratings) influenced episodic simulation of helping in younger and older adults. Replicating the findings from Chapter 2, I demonstrate that episodic simulation increases willingness to help, scene imagery, emotional concern, and theory of mind relative to a baseline condition similarly in younger and older adults. Moreover, both groups were more willing to help overall when they rated the scenario as more similar to their previous experiences.

Nevertheless, a series of mediation analyses revealed striking differences between younger and older adults in the mechanisms through which episodic simulation affects willingness to help (Gaesser et al., 2017; Sawczak et al., 2019; Chapter 2). Specifically, younger adults' previous experience was found to influence their willingness to help via indirect paths of scene imagery and perspective taking. While in older adults, only perspective taking was found to mediate this relationship. Taken together this work suggests that despite situation similarity influencing one's willingness to help in both younger and older adults, the mechanisms of this increase differ, perhaps according to one's access to previous related experiences.

Chapter 4 examines the role of time spent imagining on younger and older adults' episodic simulation. Episodic retrieval has been shown to take significantly longer than semantic retrieval and age exacerbates this difference (Spaniol et al., 2006), possibly due to general age-related slowing (Salthouse, 2010). Previous studies examining age differences in episodic simulation have tended to use a set amount of time that is the same for both older and younger adults (Addis et al., 2008; Chapter 2) and this may have contributed to some of the observed age differences. Thus, we aimed to determine whether time spent imagining plays a role in younger and older adults' production of internal and external details, phenomenological experience, and willingness to help. Participants were given 45, 60, or 74 seconds to imagine helping a person in need (or to complete the control condition). Notably, the study revealed a discrepancy between the effect of time on the number of internal details produced and one's willingness to help the person in need, such that willingness to help (as well as participants' phenomenological experience of the imagined event) was unaffected by the time manipulation, while the number of internal details produced increased with time spent imagining. Taken together, these findings suggest that episodic simulation itself may be a fast process, but describing the imagined event takes time.

Finally, in Chapter 5, I provide a brief overview of the findings contained in the present thesis and discuss the implications of these findings for our understanding of episodic simulation across the lifespan.

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Chapter 2: Episodic simulation of helping behaviour in younger and older adults during the COVID-19 pandemic

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Abstract

Imagining helping a person in need increases one's willingness to help beyond levels evoked by passively reading the same stories. We examined whether episodic simulation can increase younger and older adults' willingness to help in novel scenarios posed by the COVID-19 pandemic. Across 3 studies we demonstrate that episodic simulation of helping behaviour increases younger and older adults' willingness to help during both everyday and COVID-related scenarios. Moreover, we show that imagining helping increases emotional concern, scene imagery, and theory of mind, which in turn relate to increased willingness to help. Studies 2 and 3 also showed that people produce more internal, episodic-like details when imagining everyday compared to COVID-related scenarios, suggesting that people are less able to draw on prior experiences when simulating such novel events. These findings suggest that encouraging engagement with stories of people in need by imagining helping can increase willingness to help during the pandemic.

Keywords: episodic simulation, COVID-19, helping behavior, aging, scene imagery

Introduction

Since late 2019, global newsfeeds have been filled with stories about people facing unprecedented hardships due to COVID-19. While exposure to these stories may engender empathy and encourage people to lend a hand, recent research has shown that imagining helping a person in need increases one's willingness to help more than passively reading the same stories (Gaesser & Schacter, 2014; Gaesser et al., 2018; 2020, see O'Connor & Fowler, 2022 for review). This sort of imagination relies on the ability to 'try out' different scenarios by creating mental simulations of events that could happen in the future (i.e., episodic future thinking; Schacter, Addis, & Buckner, 2008; Schacter, Benoit, De Brigard, & Szpunar, 2015; Taylor & Schneider, 1989). According to the *constructive episodic simulation hypothesis*, individuals draw on episodic memory to create these hypothetical scenarios, flexibly recombining elements of past experiences to simulate new situations (Schacter & Addis, 2007, 2020). Since the global pandemic is an unfamiliar scenario for most people, it is unclear whether episodic simulation will increase willingness to help for COVID-related scenarios. We aimed to test this in the current study.

From Imagination to Implementation

Episodic simulations, wherein one 'tries out' potential future events, have been linked to emotion regulation, and the creation and implementation of plans (Jing, Madore, & Schacter, 2016, 2017; Taylor & Schneider, 1989; Taylor, Pham, Rivkin, & Armor, 1998). In addition to mentally working-through hypothetical events, research suggests that these mental simulations can increase the likelihood that a simulated behaviour will take place (Taylor et al., 1998). For instance, imagining specific future behaviours (like voting) influences participants' subjective likelihood of the event taking place and predicts whether participants subsequently engage in the imagined behaviour (Libby et al., 2007; Gregory et al.,1982). Similarly, when imagining helping others, research has found a link between episodic simulation and the amount people donate (Gaesser et al., 2018; 2020). Importantly, high quality, easily imagined events are thought to be more believable future events and subsequently, participants are more likely to complete the imagined event (D'Argembeau & Jimenez, 2020; Baumeister, Masicampo, & Vohs, 2011).

In terms of willingness to help, a series of studies by Gaesser & Schacter (2014) demonstrated that participants were more willing to help others in need after simulating helping scenarios compared to several control conditions. Notably, participants were more willing to help someone after simulating helping compared to 1) simply being exposed to the plight of the other person, 2) considering the journalistic style of the story, and 3) merely generating ways in which the person could be helped (but not imagining being actively involved). As such, the act of simulation and the subjective experience of the pre-lived scenario appear to play a large role in increasing willingness to help. They also found that *remembering* a time when you helped someone in a similar situation was effective at increasing willingness to help (Gaesser & Schacter, 2014). Notably, if a situation of need was completely novel and participants were unable to recall a related helping event, then willingness to help remained at baseline (Gaesser & Schacter, 2014). Thus, it is possible that while episodic simulation allows people to overcome the narrowness of their past experience, there may be limitations when dealing with a situation as unprecedented as COVID-19.

Episodic Simulation in Aging

Research indicates that episodic memory declines with age and similar deficits have also been observed for episodic simulation (Addis, Wong & Schacter, 2008). Indeed, older adults have been shown to produce more semantic (i.e., general facts) and fewer episodic (i.e., event-related) details than younger adults when asked to remember past or imagine future events (Addis et al., 2010; Addis et al., 2008; Cole, Morrison, & Conway, 2013).

To date, few studies have examined age differences in the effect of episodic simulation on willingness to help, and those that have suggest that the underlying mechanisms may differ with age. For instance, Gaesser et al. (2017) demonstrated that episodic simulation can increase older adults' willingness to help relative to a baseline condition. Importantly, subjective scene imagery similarly predicted willingness to help in both older and young adults, while a trend was found for theory of mind to be more strongly related to willingness to help in younger adults (Gaesser et al., 2017). Similar findings from Sawczak et al. (2019) also suggest that episodic simulation of helping can increase willingness to help across the lifespan, but episodic simulation increased younger adults' empathic concern more than it did older adults (Sawczak et al., 2019; see also Vollberg, Gaesser, & Cikara, 2021). Thus, while episodic simulation can increase willingness to help in older adults, it may do so via different mechanisms than in younger adults.

The Role of Familiarity in Episodic Simulation

As discussed, scene context appears to be particularly important for successful simulation of future events. Events imagined in familiar contexts are rated as being clearer than those set in unfamiliar contexts (Arnold, McDermott, & Szpunar, 2011). In a study examining younger adults, Gaesser et al. (2018) demonstrated that familiar spatial contexts facilitated a *greater* willingness to help than unfamiliar contexts when imagining helping. Moreover, scene familiarity influenced subjective vividness of the scene and increased perspective-taking of the person in need, which in turn influenced participants' willingness to help (Gaesser et al., 2018; 2020; see Gaesser, 2020 for review). What remains unclear is whether episodic simulation will increase willingness to help when the entire scenario is novel, such as those posed by the pandemic.

Imagining highly unfamiliar scenarios has been shown to increase task demands by requiring individuals to access disparate, unrelated sources of information (Robin & Moscovitch, 2014; Weiler et al., 2010). Given that cognitive control is known to decline with age (e.g., Amer, Campbell, & Hasher, 2016), the increased combinatorial demands of imagining unfamiliar, COVID-related helping scenarios may prove challenging for older adults. Thus, we might expect an ag–related decline in the ability to simulate helping in novel, COVID-related scenarios. Given the current global situation, and the time it may take for society to recover from the pandemic, understanding the potential cognitive mechanisms underlying age differences in willingness to help has important implications for society.

Current Studies

We aimed to test whether episodic simulation of helping scenarios can be used to increase younger and older adults' willingness to help in novel, pandemic-related scenarios. Across three online experiments, participants read a series of problem scenarios (half related to COVID-19, half everyday problems) and for each one they either imagined helping the person in need or completed a control condition (in which they judged the story source). Additionally, in Studies 2 and 3 participants also typed open-ended descriptions of their source judgements and imagined scenarios. Participants then rated their willingness to help the person in need and their phenomenological experience of the scenario.

Study 1

In addition to replicating previous findings in everyday scenarios, we hypothesized that episodic simulation would increase willingness to help in COVID-related scenarios, but maybe to a lesser degree in older than younger adults. We also expected that phenomenological experiences (i.e., scene imagery, emotional concern, and subjective theory of mind) would strongly relate to willingness to help in both story contexts.

Methods

Participants

This study was pre-registered on AsPredicted (https://aspredicted.org/blind.php?x=bd4z8w). Based on previous research using this paradigm online (Gaesser et al., 2018), we aimed to test 100 young adults (18-35 years) and 100 older adults (60-80 years). Participants were recruited through a Qualtrics' Research Panel and testing took place between April-June 2020. All participants were Canadian residents who were 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). All participants were compensated for their time. In total, 219 participants completed the study, and 10 study responses were removed due to having duplicate IP addresses. A further 9 participants were removed due to taking >2.5 SD longer than their age cohort to complete the study. Data collection continued until 100 younger (M = 28.05, SD = 5.48, 59% women, 2% other) and 100 older adults (M = 67.00, SD = 4.52, 51% women) with usable data completed the study. Among younger adults 52% self-identified as White, Caucasian, or European, 20% as Asian, 10% as Black or African, 5% as Canadian, 4% as mixed ethnicity, 4% as unknown or refused to answer, 3% as Middle Eastern, and 2% as Hispanic or Latin American. Among older adults, 74% self-identified as White, Caucasian, or European, 19% as Canadian or American, 3% as Asian, 1% as Black or African, 1% as mixed ethnicity, 1% as Jewish, and 1% as unknown or refused to answer.

Procedure

The paradigm used in this study was adapted from previous research on episodic simulation of helping behaviour (Gaesser & Schacter 2014; Gaesser et al., 2018). In a within-subjects design, participants were presented with one-line stories depicting examples people in need of help. Half of the stories described everyday examples of people in need (e.g., "This person is locked out of their house"), while the other half described scenarios that are specific to the COVID-19 pandemic (e.g., "This person is out of essentials due to panic buying"; see supplementary information [SI] for a list of the scenarios). Stories were pseudorandomized into one of two conditions wherein participants were asked to either: 1) focus on the story by considering its journalistic style and online media source (No Helping condition) or 2) imagine a vivid scenario of helping the person in need (Imagine Helping condition). These conditions are similar to those used in previous work (Gaesser & Schacter, 2014; Gaesser et al., 2018).

Participants were presented with the instructions for the task and completed two practice trials (one for each condition) to become familiar with the task. Participants were asked whether they understood the instructions and further instructions/examples were given to those who did not understand the instructions, while those who reported understanding the task were immediately forwarded to the trials. Given the online nature of data collection, anyone still not understanding the instructions after two checks was excluded from the study; although this exclusion criterion was not included in our preregistration, it was used to ensure that participants understood the instructions.

For each trial, participants were presented with the story for 10 seconds, followed by a 60 second condition prompt (during which time, they were supposed to either imagine helping the person or consider the journalistic style of the story). 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), scene 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), and as a measure of perspective taking/subjective theory of mind, 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 also rated each scenario on how similar it was to situations they have previously experienced (1 = not at all – 7 = very similar). These ratings remained on the screen until participants responded to all of them (i.e., self-paced). Participants completed 12 trials with 6 stories in each condition (3 COVID-related, 3 depicting everyday scenarios). Participants then completed a demographic questionnaire.

Results

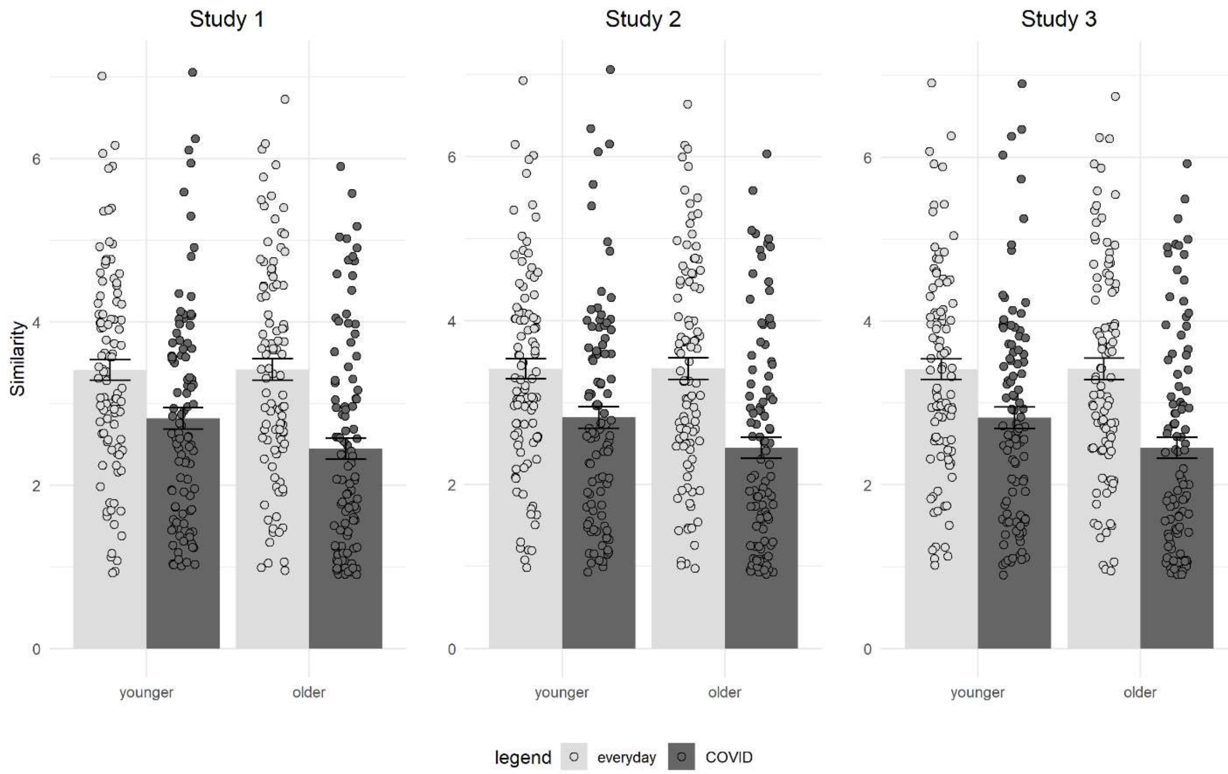
Similarity of Everyday vs COVID-related Scenarios

As a manipulation check, we conducted a 2 (Story Type: Everyday vs. COVID-19) X 2 (Age: Younger vs. Older Adults) ANOVA on participants' ratings of situation similarity (NB this analysis was not part of the preregistration). As expected, we found a main effect of story, F (1, 198) = 121.65, $p < .001$, $\eta p^2 = 0.381$, reflecting everyday scenarios ($M = 3.42$, $SE = .09$)

being rated as more similar to situations participants had previously experienced compared to COVID-related scenarios (*M* = 2.64, *SE* = .09). There was also a story by age interaction, F (1, 198) = 6.98, p = .009, ηp^2 = 0.034. Follow-up analyses revealed that this was due to a larger effect of story in older adults (everyday: *M* = 3.42, *SE* = .13; COVID: *M* = 2.45, *SE* = .13), t (99) = 9.00, p < .001, however the effect was still significant in younger adults (everyday: *M* = 3.41, *SE* = .12; COVID: *M* = 2.82, *SE* = .13), t (99) = 6.45, p < .001 (see Figure 1). The main effect of age was not significant, p = .279. Thus, participants thought that COVID-related scenarios were less similar to previous experiences than everyday scenarios, and this effect was more pronounced in the older group.

Figure 2.1.

Participants' ratings of situation similarity across everyday and COVID-related stories in Studies 1-3.



Note: Individual data points are jittered for ease of visualization, error bars represent standard error of the mean.

Willingness to Help by Condition and Story Manipulation

We used hierarchical mixed effects modeling[1] (e.g., Sommet & Morselli, 2017) to explore the effect of Condition (No-helping vs. Imagine Helping), Story Type (Everyday vs. COVID-19), and Age (Younger vs. Older Adults) on willingness to help while accounting for random effects of individual stories (i.e., story number) and participants. We constructed multiple models in a hierarchical fashion, adding predictors to the model one at a time. We then compared the models to assess whether each variable added to the overall predictability of willingness to help. To avoid overparameterization, the most parsimonious model was then constructed by retaining only the variables that significantly added to the model. The initial base

[1] Note that this differs from the preregistration, in which we proposed an ANOVA approach. However, mixed effects modeling was rightly suggested by a reviewer, as it can account for stimulus effects (particularly important in this case, as we are using a novel set of stimuli generated for this study).

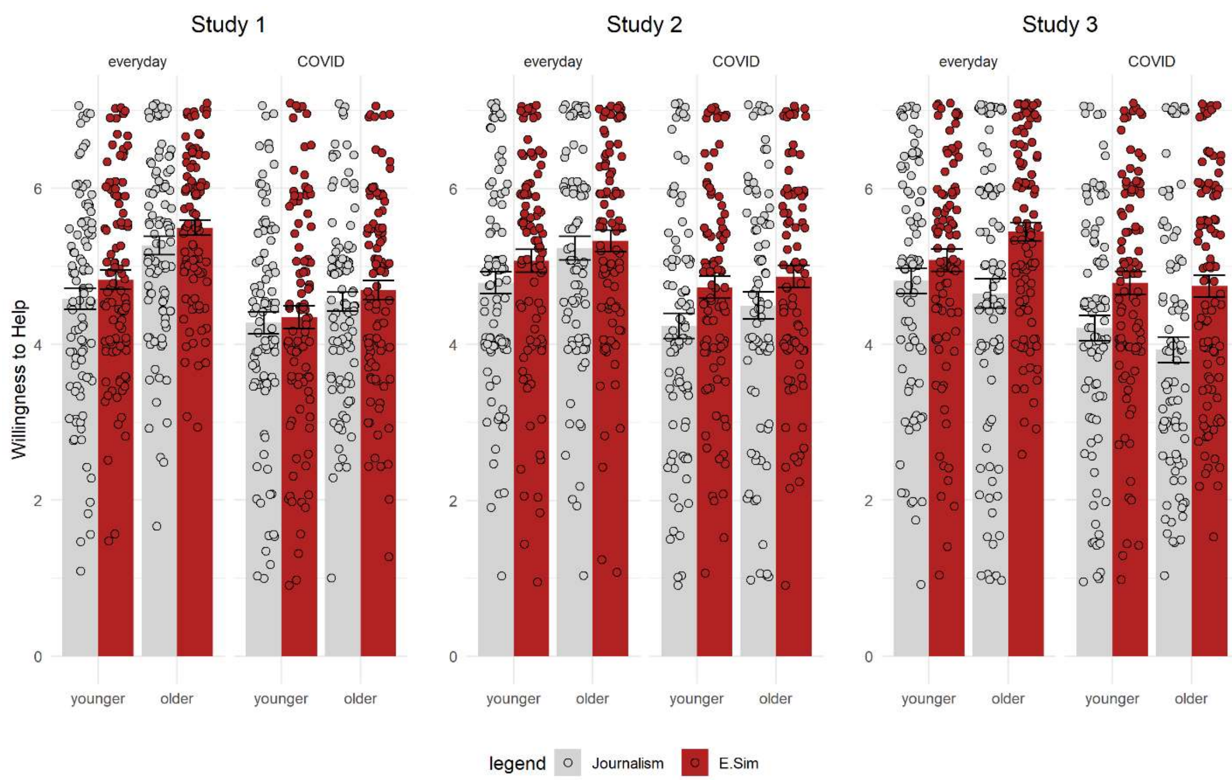
model indicated a small correlation (ICC = 0.29) between willingness to help ratings from individual participants. Story number was added to the model as a random effect, and was found to significantly predict willingness to help, $\chi 2(1) = 377.12$, $p < .001$; ICC = 0.42. Thus, both random effects were retained for the analysis. Fixed factors were added to the model in the following order: Condition, Story Type, Condition x Story Type, Age, Condition x Age, Story x Age, Age x Condition x Story. Finally, the most parsimonious model was constructed by including only predictors that improved model fit.

Condition was found to improve model fit, $\chi 2(1) = 9.00$, $p = .003$, as did Age, $\chi 2(1) = 8.29$, $p = .004$, and the interaction between Age and Story Type, $\chi 2(1) = 7.30$, $p = .007$; these factors were entered into the best fit model. All other predictors did not improve model fit: Story Type, $\chi 2(1) = 3.43$, $p = .063$; Condition x Story Type, $\chi 2(1) = 0.88$, $p = .346$; Condition x Age, $\chi 2(1) = 0.20$, $p = .652$; Condition x Story Type x Age, $\chi 2(1) = 0.18$, $p = .669$.

The best fit model revealed that there was an effect of Condition, $B = 0.17$, $SE = 0.06$, $t(2185.74) = 3.02$, 95% CI [0.06, 0.28], such that willingness to help was higher following episodic simulation of helping ($M = 4.82$, $SE = .18$) relative to judging journalistic style ($M = 4.65$, $SD = 18$; see Figure 2 for observed means). There was also an effect of Age, $B = 0.42$, $SE = 0.14$, $t(198)= 2.90$, 95% CI [0.14, 0.70], due to older adults' ($M = 4.94$, $SE = .19$) overall higher willingness to help than younger adults ($M = 4.52$, $SE = .19$). The interaction between age and story type, $B = -0.76$, $SE = 0.34$, $t(10.56) = 2.25$, 95% CI [-1.42, -0.10], was due to older adults' reporting higher willingness to help in everyday ($M = 5.32$, $SE = .26$), compared to COVID-related scenarios ($M = 4.56$, $SE = .26$). While the direction of the effect was the same in younger adults (everyday: $M = 4.75$, $SE = .26$; COVID: $M = 4.29$, $SE = .26$), the difference failed to reach significance, $B = -0.46$, $SE = 0.34$, $t(10.56) = 1.37$, 95% CI [-1.12, 0.20]. Random effects for the best fit model were $\sigma^2 = 1.85$, ICC = 0.40, $\tau_{00\ id} = 0.89$, $\tau_{00\ StoryNumber} = 0.32$. Marginal and Conditional R^2 for the model were 0.046 and 0.425, respectively.

Figure 2.2.

Average willingness to help in younger and older adults across all conditions in Studies 1-3.



Note: Individual data points are jittered for ease of visualization, error bars represent standard error of the mean. In Study 2, neither the main effect of age nor the interactions with age were significant, but means are plotted separately by age group for the sake of comparison with Study 1 and 3.

Willingness to Help Correlations with Phenomenological Experiences

Previous research has suggested that phenomenological experiences (such as emotional concern, scene imagery, and subjective theory of mind) may be potential mechanisms through which episodic simulation increases willingness to help (Gaesser & Schacter, 2014; Gaesser et al., 2018; Sawczak et al., 2019). Indeed, scene imagery and subjective theory of mind were found to be higher following episodic simulation relative to the journalistic style condition (see SI; this exploratory analysis was not preregistered). As in previous work, scales measuring emotions experienced in response to the scenarios were averaged to form an emotional concern index per condition, as were ratings of scene coherence and detail to form a scene imagery index reflecting the overall vividness of the scene produced by participants (Batson, 2011; Gaesser, Dodds & Schacter, 2017). To explore whether these phenomenological experiences contribute to participants' increased willingness to help following episodic simulation in everyday and COVID-related scenarios, we examined the repeated measures correlations (Bakdash & Marusich, 2017) between these measures and willingness to help using the 'rmcorr' package in R. Because there was an interaction between story type and age on willingness to help, correlational analyses were conducted within each story type for younger and older adults separately. We then used Fisher's Z transformations to compare the relationship between phenomenological experiences and willingness to help between age groups (Meng, Rosenthal, & Rubin, 1992; see Table 2.1 for r_{rm} coefficients and Fisher's z transformations). A Bonferroni adjusted alpha level (p <.004) was used to correct for the 12 tests performed.

Table 2.1
Within-subject correlations between phenomenological experience and willingness to help across Studies 1-3

Phenomenological Experience	Emotional Concern			Scene Imagery			Theory of Mind		
Scenarios	Younger	Older	Young vs Old (Fisher's *z*)	Younger	Older	Young vs Old (Fisher's *z*)	Younger	Older	Young vs Old (Fisher's *z*)
<u>Study 1</u>									
Everyday	.575**	.499**	0.75 (.22)	.515**	.262	2.10 (.02)	.709**	.656**	0.69 (.24)
COVID	.425**	.599**	-1.66 (.05)	.158	.293*	-0.99 (.16)	.567**	.725**	-1.92 (.03)
<u>Study 2</u>									
Everyday	.472**	.503**	-0.27 (.39)	.429**	.298	1.01 (.16)	.742**	.769**	-0.42 (.34)
COVID	.345**	.527**	-1.51 (.07)	.495**	.445**	0.43 (.33)	.626**	.698**	-0.86 (.20)
<u>Study 3</u>									
Everyday	.682**	.562**	1.33 (.09)	.331*	.111	1.57 (.06)	.733**	.724**	0.13 (.45)
COVID	.529**	.544**	-0.14(.56)	.441**	.384**	0.46 (.32)	.715**	.770**	-0.83 (.20)

Note: Correlation values reflect the within-subject correlation (r_{rm}) between phenomenological experience and willingness to help. Correlation p-values are noted as: $^{*}p < .004$. $^{**}p < .001$. Fisher's z p-values are presented in parentheses.

Individuals within both age groups reliably exhibited a significant positive relationship between willingness to help and emotional concern for both the everyday and COVID-related scenarios, suggesting that as emotional concern increases, so does one's willingness to help the person in need. A comparison of these correlations revealed that the relationship between willingness to help and emotional concern was stronger in older, compared to younger adults in the COVID-related scenarios, suggesting that as emotional concern increases, so does one's willingness to help and that the strength of this relationship may differ by story context and age (see Table 2.1 for Fisher's z values comparing correlation coefficients between age groups and SI for scatterplots).

For scene imagery, younger adults exhibited a significant positive relationship between willingness to help and scene imagery for the everyday scenarios, while older adults did not. Moreover, a comparison of these correlations using Fisher's r to z transformation revealed that the relationship between willingness to help and scene imagery was stronger in younger, compared to older adults in the everyday helping scenarios, suggesting that scene imagery may be a stronger predictor of willingness to help in younger adults in typical scenarios. However, in terms of COVID-related scenarios, only older adults exhibited a relationship between scene imagery and willingness to help; nevertheless, the Fisher's transformation determined that there was no age-related difference in the relationship between scene imagery and willingness to help in COVID-related scenarios.

For subjective theory of mind, individuals in both age groups exhibited a relationship between willingness to help and subjective theory of mind for the everyday and COVID-related scenarios. Fisher's z transformation revealed that the relationship between willingness to help and subjective theory of mind was stronger in older, compared to younger adults in the COVID-related scenarios, suggesting that as subjective theory of mind increases, so does one's willingness to help and that the strength of this relationship may differ by story context and age.

Discussion

In Study 1, we found that episodic simulation of helping increased willingness to help in both older and younger adults in both COVID-related and everyday scenarios. However, the relationship between willingness to help and participants' emotional concern, scene imagery, and subjective theory of mind varied with age and story type. In Study 2, we aimed to replicate these effects and gain further insight into participants' imagined events.

Study 2

Study 2 used the same procedure as Study 1, except participants typed a description of how they imagined helping the person in need or where they thought the story was from. This prompt encouraged participants to engage with the task and allowed us to determine whether participants were performing the task correctly. We also scored participants' descriptions of their imagined events in terms of internal (episodic-like) and external (semantic information, commentary, repetitions) details, using the autobiographical interview protocol (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002), to determine whether the type of details produced differed with age and story type. We expected participants to produce more internal details when imagining everyday scenarios due to having memories for similar events. Conversely, we expected more external details to be produced when imagining the more unfamiliar COVID-related scenarios due to a lack of personal experiences on which to draw.

Methods

Participants

We aimed for the same sample size as Study 1 and the same recruitment and inclusion criteria were used. Additionally, IP addresses that completed Study 1 were excluded from participating. A total of 224 people completed Study 2 between June-July 2020. Similar exclusion criteria were used when cleaning the data, such that 7 participants were removed for taking >2.5 SD longer than their age cohort to complete the study, 2 younger adults were removed for typing gibberish in the open-ended response boxes, and 22 participants were removed for completing the wrong task on more then 50% of all trials (i.e., more than 6 trials, see Data Screening for details). Additionally, 4 older adults were removed for scoring below 11 on the adapted version of the MMSE (see procedure for details). The final sample (N= 189) consisted of 96 younger adults (M = 28.17, SD = 5.20, between the ages of 18-36, 64.6% women) and 93 older adults (M = 66.62, SD = 4.75, between the ages of 60-79, 53.8% women). Among younger adults 43.75% self-identified as White, Caucasian, or European, 31.25% as Asian, 7.29% as Canadian, 5.21% as Black or African, 3.13% as Hispanic, Latin, or South American, 2.08% as mixed ethnicity, 2.08% as Middle Eastern, and 2.08% Indian, 1.04% as Native American, and 2.08% of as unknown or refused to answer. Among older adults, 67.03% self-identified as White, Caucasian, or European, 15.38% as Canadian (including French Canadian), 4.39% as Asian, 3.29% as Jewish, 2.19 as Indian and Sri Lankan, 1.09% as Middle Eastern, 1.09% as Jamaican, 1.09% as Egyptian, 1.09% as Aboriginal, 1.09% as mixed ethnicity, and 2.19% as unknown or refused to answer.

Procedure

The procedure was the same as Study 1 with the addition of open-ended responses collected during the condition prompts. Specifically, participants were given 60 seconds to type a description of their imagined scenario and/or thoughts while judging the journalistic style of the story (see SI for transcript examples). Immediately after each condition prompt, participants performed the same ratings as in Study 1 (i.e., willingness to help, scene coherence, etc.). After completing all trials, participants rated each story on how safe it was to help the person in need (1 = not at all – 7 = very safe). They were then forwarded to an online version of the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975), a tool used in aging research to screen for cognitive deficits. Since the study was conducted online, portions of the MMSE that require in-person responses (i.e., drawing) were removed from the test. Similar modifications have been used in the past to administer the MMSE remotely, with high internal consistency and correlations to the original MMSE found (see Kennedy et al., 2014 for more information). These modifications resulted in a maximum score of 14, therefore we selected scores <11 as a cut-off for potential MCI to keep scores proportionate to those used for remote administration of the MMSE (Kennedy et al., 2014). Participants then completed a demographics questionnaire.

Data Screening

Using participants' open-ended descriptions, each trial was scored as being completed correctly or incorrectly. Incorrect trials were defined as explicit mention of performing the opposite task (e.g., judging the journalistic style of a story on imagining helping trials); incorrect trials were excluded from the analyses.

Additionally, open ended responses were scored for the type of details produced based on the coding scheme outlined in the Autobiographical Interview scoring manual (Levine et al., 2002). The criteria define internal details as those that are directly related to the event, while external details consist of extraneous and semantic information unrelated to the event (including commentary and references to other episodes; Levine et al., 2002). While this scoring method is typically used to code larger narratives in which participants describe their imagined events over the course of several minutes, it is important to note that the present study limits participant responses to 60 seconds. Scoring was conducted independently by 2 trained scorers. Similar to previous research (Levine et al., 2002; Wang et al., 2016), interrater reliability was assessed by comparing 25% of the open-ended responses in terms of the number of internal and external details scored. ICC for the number of internal and external details produced were .827 and .919, respectively.

Results

Similarity of Everyday vs COVID-related Scenarios

In keeping with Study 1, we performed a 2 (Story Type: Everyday vs. COVID-19) X 2 (Age: Younger vs. Older Adults) ANOVA on participants' ratings of situation similarity as a manipulation check. Replicating Study 1, we found a main effect of story, F (1, 185) = 115.57, $p < .001$, $\eta p^2 = 0.385$, reflecting everyday scenarios (M = 3.46, SE = .11) being rated as more similar to situations participants had previously experienced compared to COVID-related scenarios (M = 2.58, SE = .10). Once again, we found a story by age interaction, F (1, 185) = 7.89, p = .005, $\eta p^2 = 0.041$. Follow-up analyses revealed that there was a larger effect of story in older adults, t (90) = 8.79, $p < .001$, such that everyday (M = 3.64, SE = .16) scenarios were seen as more similar to previous experiences than COVID-related scenarios (M = 2.52, SE = .12). Importantly, younger adults also rated everyday scenarios (M = 3.27, SE = .15) higher in similarity to previous experiences compared to COVID-related scenarios ($M = 2.63$, $SE = .15$), $t(95) = 6.18$, $p < .001$. The main effect of age was not significant, $p = .682$.

Willingness to Help by Condition and Story Manipulation

As with Study 1, we built mixed effects models hierarchically to explore the effect of Condition (No-helping vs. Imagine Helping), Story Type (Everyday vs. COVID-19), and Age (Younger vs. Older Adults) on willingness to help while accounting for random effects present in individual stories (i.e., story number) and participants. As with Study 1, the initial intercept model indicated a correlation (ICC = 0.32) between willingness to help ratings within individual participants. Story number was added to the model as a random effect, and found to significantly predict willingness to help, $\chi 2(1) = 298.31$, $p < .001$; ICC = .45. Thus, both random effects were retained for the analysis. Fixed factors (see Study 1 for list) were added to the model, and the most parsimonious model was constructed by including only predictors that improved model fit.

Condition was found to improve model fit, $\chi 2(1) = 21.50$, $p < .001$, as did the age by condition interaction $\chi 2(1) = 3.91$, $p = .047$. All other predictors did not improve model fit: Story Type, $\chi 2(1) = 2.69$, $p = .101$; Condition x Story Type, $\chi 2(1) = 1.68$, $p = .195$; Age, $\chi 2(1) = 1.84$, $p = .174$; Age x Story Type $\chi 2(1) = 1.37$, $p = .242$; Condition x Story Type x Age, $\chi 2(1) = 0.14$, $p = .707$. Thus, the most parsimonious model included condition and the condition by age interaction.

As with Study 1, best fit model estimates indicate that there was an effect of Condition, $B = 0.41$, $SE = 0.09$, $t(1735) = 4.73$, 95% CI [0.24, 0.59], such that willingness to help was higher following episodic simulation ($M = 5.03$, $SE = .20$) of helping relative to judging journalistic style ($M = 4.75$, $SE = .20$; see Figure 2). In this case, we found an interaction between condition and age which was explained by older adults' ($M = 4.93$, $SE = .22$) higher willingness to help than younger adults (M = 4.56, SE = .22) in the journalism condition, B = 0.37, SE = 0.18, t(263.6)= 2.04, 95% CI [0.01, 0.72], but not in the episodic simulation condition (older: M = 5.09, SE = .22; younger: M = 4.98, SE = .22), B = 0.11, SE = 0.17, t(230) = 0.66, 95% CI [-0.22, 0.45]. Moreover, the effect of condition was found to be significant in younger adults, t(1735) = 4.73, p< .001, and trending in older adults, t(1746) = 1.76, p= .08. Random effects for the best fit model were σ^2 = 1.81, ICC = 0.45, $\tau_{00\ id}$ = 1.09, $\tau_{00\ StoryNumber}$ = 0.40. Marginal and Conditional R^2 for the model were 0.012 and 0.459, respectively. Thus, older adults' higher willingness to help in the journalism condition may have reduced our ability to find a significant effect of episodic simulation in that group (i.e., older adults' willingness to help may have already been at or close to ceiling in the baseline journalism condition in this study). Notably, because pandemic-related scenarios may include safety concerns (i.e., whether it is safe to help the person in need), best fit models were also generated with participants' safety ratings as a random factor, however this did not change the results (see SI).

Willingness to Help Correlations with Phenomenological Experiences

We again observed that episodic simulation increased emotional concern, scene imagery, and subjective theory of mind relative to the journalistic style condition (see SI). We performed repeated measures correlational analyses between these phenomenological experiences and willingness to help separately for younger and older adults' in both everyday and COVID-related scenarios (refer to Table 1 for correlation coefficients and Fisher's z comparisons). A Bonferroni adjusted alpha level (p <.004) was used to correct for multiple comparisons.

Breaking these correlations down by story type, individuals in both age groups exhibited a significant positive relationship between willingness to help and emotional concern for both the everyday, and COVID-related scenarios.

For scene imagery, younger adults exhibited a significant positive relationship between willingness to help and scene imagery for the everyday scenarios, however, replicating Study 1 the relationship was not significant for older adults when correcting for multiple comparisons. However, the Fisher's transformation determined that there was no age-related difference in the relationship between scene imagery and willingness to help. Further, in COVID-related scenarios both younger and older adults exhibited a significant relationship between scene imagery and willingness to help.

For subjective theory of mind, individuals in both age groups exhibited a relationship between willingness to help and subjective theory of mind for both the everyday and COVID-related scenarios.

Exploratory Analysis of Internal and External Details

Study 2 included participants' written descriptions of the scenes they imagined. Previous research suggests that the type of details produced may differ when imagining familiar vs unfamiliar events (de Vito, Gamboz, & Brandimonte, 2012), with familiar scenarios giving rise to more episodic details and unfamiliar scenarios relying more on semantic details (Wang et al., 2016). Given the unfamiliar contexts involved with the COVID-19 pandemic, an exploratory analysis was conducted to assess the type of details produced when participants imagined helping a person in need.

We used hierarchical mixed effects modeling to explore the effect of Story Type (Everyday vs. COVID-19), Age (Younger vs. Older Adults), and story similarity ratings on internal and external details produced on imagine helping trials. As with the main analysis, both participant and story number were added to the model as random effects. Fixed factors of story type, age, and similarity ratings were then added to model individually, and the most parsimonious model was constructed to include only predictors that improved model fit.

For internal details, there was a strong correlation between the number of details produced within each participant (ICC = 0.79). Story number was also found to significantly predict the number of internal details produced, $\chi 2(1) = 118.19$, $p < .001$; ICC = 0.38. Thus, both random effects were retained for the analysis. Age, $\chi 2(1) = 5.01$, $p = .02$, and story type, $\chi 2(1) = 5.20$, $p = .02$, were significant predictors of the number of internal details produced and retained to construct the best fit model. There was also a trend for the story type x similarity interaction, $\chi 2(1) = 3.72$, $p = .05$, however all other factors did not significantly predict the number of internal details produced: Story Type x Age, $\chi 2(1)= 0.00$, $p = .97$; Similarity, $\chi 2(1)= 3.21$, $p = .07$, Similarity x Age, $\chi 2(1)= 0.00$, $p = .97$; Similarity x Story Type x Age, $\chi 2(1)= 0.31$, $p = .57$.

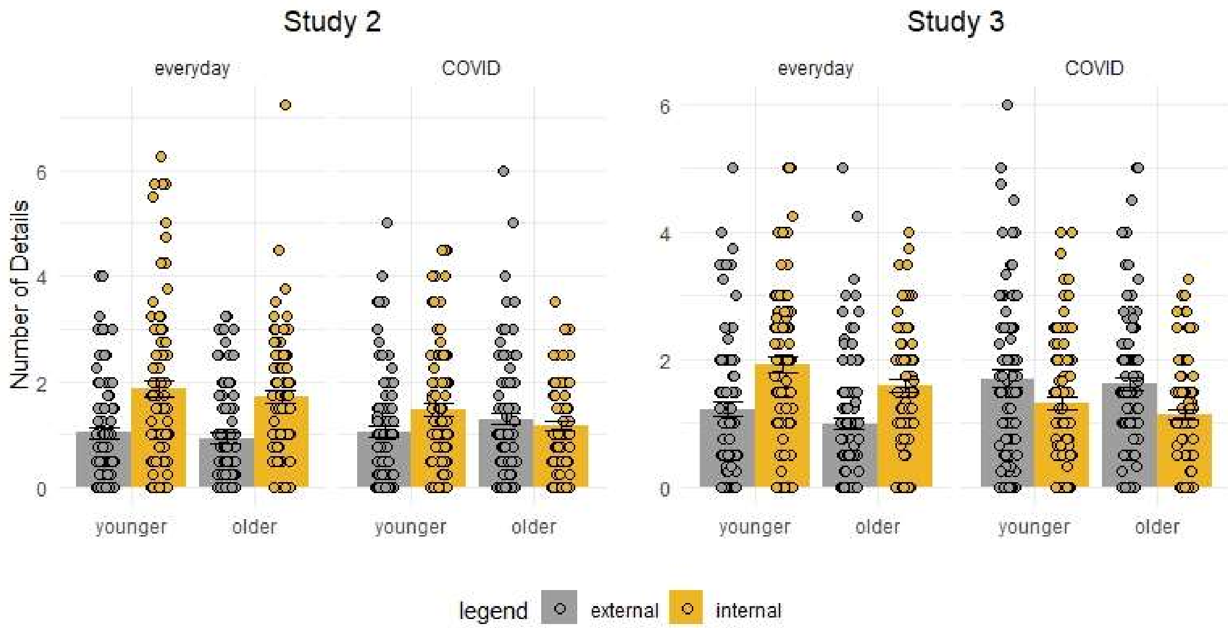
The best fit model revealed that the effect of age, $B = -0.33$, $SE = 0.15$, $t(182.30) = 2.26$, 95% *CI* [-0.62, -0.04], was due to older adults producing fewer internal details overall ($M = 1.46$, $SE = .19$) compared to younger adults ($M = 1.80$, $SE = .18$; see Figure 3). The effect of story, $B = -0.74$, $SE = 0.32$, $t(8.73) = 2.32$, 95% *CI* [-1.36, -0.11], was due to participants producing fewer internal details in COVID-related scenarios ($M = 1.26$, $SE = .23$) compared to everyday scenarios ($M = 2.00$, $SE = .23$). This pattern is in line with previous research showing that the type of details produced differs when imagining familiar vs unfamiliar events (de Vito et al., 2012), with familiar scenarios giving rise to more episodic details compared to unfamiliar scenarios (Wang et al., 2016). Random effects for the best fit model were $\sigma^2 = 1.27$, ICC = 0.46, $\tau_{00\ id} = 0.77$, $\tau_{00\ StoryNumber} = 0.28$. Marginal and Conditional R^2 for the model were 0.046 and 0.492, respectively.

For external details, there was a correlation between the number of details produced within each participant (ICC = 0.31). Once again, story number was found to significantly predict the number of external details produced, $\chi 2(1) = 23.45$, $p < .001$; ICC = 0.34. Thus, both random effects were retained for the analysis. Only the story type x age interaction, $\chi 2(1) = 3.85$, $p = .05$, was found to be a significant predictor of the number of external details produced. All other factors were excluded from the best fit model: Age, $\chi 2(1) = 0.06$, $p = .80$; Story Type, $\chi 2(1) = 1.24$, $p = .27$; Similarity, $\chi 2(1) = 0.03$, $p = .87$; Similarity x Story Type, $\chi 2(1) = 0.02$, $p = .88$, Similarity x Age, $\chi 2(1) = 0.17$, $p = .68$; Similarity x Story Type x Age, $\chi 2(1) = 0.28$, $p = .60$.

Contrasts for the best fit model suggest that there was no effect of age on the number of external details produced in COVID-related, $B = 0.19$, $SE = 0.19$, $t(27.50) = 1.01$, 95% *CI* [-0.18, 0.56] or everyday scenarios, $B = -0.09$, $SE = 0.13$, $t(288.77) = 0.67$, 95% *CI* [-0.36, 0.18], nor was there an effect of story within younger adults (the reference population), $B = 0.03$, $SE = 0.15$, $t(13.21) = 0.17$, 95% *CI* [-0.28, 0.33]. Thus, while participants produced numerically more external details in COVID-related (older: $M = 1.15$, $SE = .13$; younger: $M = 0.99$, $SE = .13$) compared to everyday scenarios (older: $M = 0.87$, $SE = .13$; younger: $M = 0.96$, $SE = .13$), however this difference was not significant (older: $t(15.1) = 1.81$, $p = .09$; younger: $t(14.5) = 0.17$, $p = .87$). Random effects for the best fit model were $\sigma^2 = 1.03$, ICC = 0.34, $\tau_{00\ \mathrm{id}} = 0.49$, $\tau_{00\ \mathrm{StoryNumber}} = 0.04$. Marginal and Conditional R^2 for the model were 0.006 and 0.347, respectively.

Figure 2.3.

Average external and internal details produced by younger and older adults on episodic simulation trials with respect to story type.



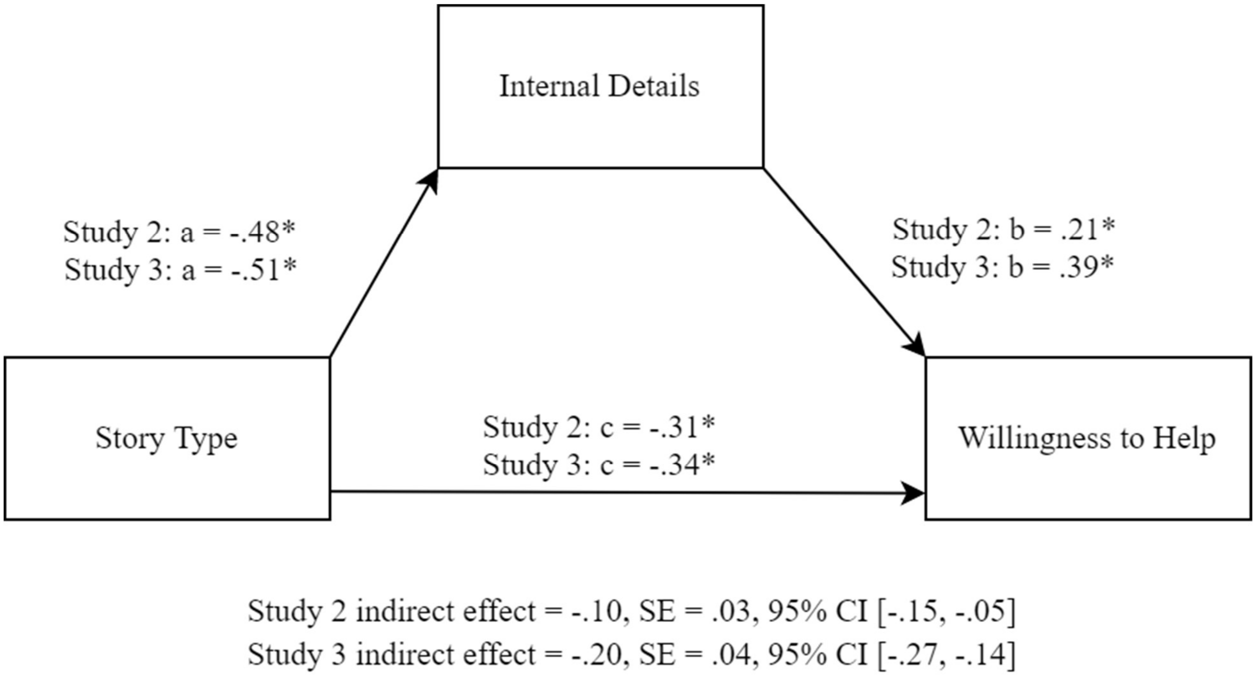
Note: Individual data points are jittered for ease of visualization, error bars represent standard error of the mean.

Modeling the Effect of Condition on Willingness to Help Through Internal Details

To further assess the influence of internal details on the relationship between the story type and willingness to help, we conducted an exploratory within-subject mediation analysis on imagine helping trials using the "MLMED" macro (Rockwood & Hayes, 2017). Willingness to help was entered as the dependent variable, story type (everyday vs COVID-related) as the independent variable, and internal details produced as a potential mediator (see Figure 4 for the effects of each path). We found a significant indirect effect of story type on willingness to help via internal details, effect = -.10, SE = .03, 95% *CI* (-.15, -.05), suggesting that COVID-19 related stories lowered participants' willingness to help (relative to the everyday baseline) by lowering the number of internal details used to construct their imagined scenes.

Figure 2.4.

Mediation models for Studies 2 &3: The effect of story type on willingness to help through internal details.



Discussion

In Study 2, we replicated our main finding of increased willingness to help following episodic simulation for age groups regardless of story type. Interestingly, our exploratory analyses revealed a dissociation between COVID and everyday scenarios and situation similarity ratings. Further, we demonstrated that the effect of story on willingness to help was mediated by the number of internal details produced. In Study 3, we aimed to replicate this effect, along with the other findings from Studies 1 and 2.

Study 3

Study 3 was a direct replication of Study 2; thus, all methods and analyses were the same.

Methods

Participants

We aimed for the same sample size, recruitment methods and inclusion criteria as Studies 1 and 2. A total of 230 people completed Study 3 between October-November 2020. The same exclusion criteria from Study 2 was used to clean the data such that 4 participants were removed for being the wrong age, 3 older adults were removed for getting less than 11 on the adapted version of the MMSE, and 26 participants were removed for completing the wrong task on more then 50% of all trials. The final sample (N= 197) consisted of 95 younger adults (M = 27.24, SD = 4.59, between the ages of 18-36, 72.6% women, 1.1% other, 2.1% prefer not to say) and 102 older adults (M = 66.51, SD = 4.68, between the ages of 60-80, 59.8% women). Among younger adults 45.26% self-identified as White, Caucasian, or European, 17.89% as Asian, 9.47% as Canadian (including French Canadian), 7.36% as Black or African, 3.15% as Indigenous or Native American, 2.10% as mixed ethnicity, 2.10% Middle Eastern, 2.10% as Indian or East Indian, 2.10% as Jewish, 1.05% as Hispanic, Latin, or South American, and 7.36% as unknown, other, or refused to answer. Among older adults, 69.6% self-identified as White, Caucasian, or European, 16.66% as Canadian (including French Canadian), 5.88% as Asian, 1.96% as mixed ethnicity, 1% as Black or African, 1% as Indian, and 3.92% as unknown or refused to answer.

Procedure

The same procedure from Study 2 was used for Study 3.

Data Screening

The same data screening methods described in Study 2 were used for Study 3, such that incorrect trials were excluded from all analyses. Interrater reliability for the number of internal and external details produced were .816 and .892, respectively.

Results

Similarity of Everyday vs COVID-related Scenarios

As with Studies 1 and 2, we performed a 2 (Story Type: Everyday vs. COVID-19) X 2 (Age: Younger vs. Older Adults) ANOVA on participants' ratings of situation similarity as a manipulation check. Replicating Study 1 and 2, we found a main effect of story, F (1, 195) = 77.70, $p < .001$, $\eta p^2 = 0.285$, reflecting everyday scenarios ($M = 3.35$, $SE = .10$) being rated as more similar to situations participants had previously experienced compared to COVID-related scenarios ($M = 2.60$, $SE = .09$). Once again, we also found a story by age interaction, F (1, 195) = 7.04, $p = .009$, $\eta p^2 = 0.035$. Follow-up analysis revealed that there was a larger effect of story in older adults, t (101) = 7.63, $p < .001$, however the effect was still significant in younger adults t (94) = 4.74, $p < .001$. Further, in this case, older adults ($M = 2.35$, $SE = .13$) rated COVID-related scenarios as being less similar to situations they had previously experienced than younger adults ($M = 2.85$, $SE = .13$), t (195) = 2.65, $p = .009$. The main effect of age was not significant, $p = .900$. Taken together, these results suggest that COVID-related scenarios were considered less similar to previous experiences than everyday scenarios, particularly to older adults.

Willingness to Help by Condition and Story Manipulation

As with Studies 1 and 2, we used mixed effects models hierarchically to explore the effect of Condition (No-helping vs. Imagine Helping), Story Type (Everyday vs. COVID-19), and Age (Younger vs. Older Adults) on willingness to help while accounting for random effects present in individual stories (i.e., story number) and participants. As with Studies 1 and 2, the initial intercept model indicated a correlation (ICC = 0.32) between willingness to help ratings within individual participants. Story number was added to the model as a random effect, and found to significantly predict willingness to help $\chi 2(1) = 307.25$, $p < .001$; ICC = .44. Thus, both random effects were retained for the analysis. Fixed factors (see Study 1 for list) were added to the model, and the most parsimonious model was constructed by including only predictors that improved model fit.

Condition was found to improve model fit, $\chi 2(1) = 61.27$, $p < .001$, as did the age by condition interaction $\chi 2(1) = 8.51$, $p = .004$. There was also a trend for the story by age interaction, $\chi 2(1) = 3.68$, $p = .055$. All other predictors did not improve model fit: Story Type, $\chi 2(1) = 3.13$, $p = .08$; Condition x Story Type, $\chi 2(1) = 3.32$, $p = .069$; Age, $\chi 2(1) = 1.84$, $p = .174$; Condition x Story Type x Age, $\chi 2(1) = 2.93$, $p = .087$. Thus, the most parsimonious model included condition and the condition by age interaction.

As with Studies 1 and 2, best fit model estimates indicate that there was an effect of Condition, $B = 0.32$, $SE = 0.09$, $t(1749) = 3.47$, 95% *CI* [0.14, 0.51], such that willingness to help was higher following episodic simulation of helping ($M = 4.99$, $SE = .21$) relative to judging journalistic style ($M = 4.47$, $SE = .21$; see Figure 2). Replicating Study 2, we found an interaction between condition and age. In this case, the interaction was due to a trend for older adults ($M = 4.29$, $SE = .23$) to report lower willingness to help than younger adults ($M = 4.65$, $SE = .23$) in the journalism condition, $B = -0.36$, $SE = 0.18$, $t(269.7)= 1.93$, 95% *CI* [-0.72, 0.01], but for no effect of age in the episodic simulation condition (old: $M = 5.00$, $SE = .23$; young: $M = 4.97$, $SE = .23$), $B = 0.03$, $SE = 0.18$, $t(233) = 0.16$, 95% *CI* [-0.32, 0.38]. Nevertheless, the effect of condition was significant in both groups (older: $t(1760) = 7.68$, $p<.001$; younger: $t(1750) = 3.47$, $p<.001$). Thus, while there was an overall effect of condition on willingness to help, there was a trend for older adults to report lower willingness to help in the journalism condition. Random effects for the best fit model were $\sigma^2 = 1.95$, ICC = 0.45, $\tau_{00\ id} = 1.16$, $\tau_{00\ StoryNumber} = 0.43$. Marginal and Conditional R^2 for the model were 0.022 and 0.462, respectively.

Willingness to Help Correlations with Phenomenological Experiences

Again, we found that episodic simulation increased emotional concern, scene imagery, and subjective theory of mind relative to the journalistic style condition (see SI). In line with Studies 1 and 2, we performed within-subjects correlations for each story type separately in younger and older adults and then compared the relationship between phenomenological experiences and willingness to help between age groups (refer to Table 1 for correlation coefficients and Fisher's z transformations). A Bonferroni adjusted alpha level (p <.004) was used to correct for multiple comparisons.

Individuals in both age groups exhibited a significant positive relationship between willingness to help and emotional concern for both the everyday and COVID-related scenarios.

For scene imagery, younger adults exhibited a significant positive relationship between willingness to help and scene imagery for the everyday scenarios, while older adults did not. Fisher's z determined that there was a trend toward an age difference between these relationships. Nevertheless, there was a significant relationship between scene imagery and willingness to help in COVID-related scenarios for both younger and older adults.

For subjective theory of mind, individuals in both age groups exhibited a relationship between willingness to help and subjective theory of mind for both the everyday and COVID-related scenarios.

Internal and External Details

As with Study 2, we used hierarchical mixed effects modeling to explore the effect of Story Type (Everyday vs. COVID-19), Age (Younger vs. Older Adults), and story similarity ratings on internal and external details produced on imagine helping trials with participant and story number entered into the model as random effects. Once again, the most parsimonious model was constructed to include only predictors that improved model fit.

For internal details, there was a strong correlation between the number of details produced within each participant (ICC = 0.31). Replicating Study 2, story number was found to significantly predict the number of internal details produced $\chi 2(1) = 131.22$, $p < .001$; ICC = 0.43. Thus, both random effects were retained for the analysis. There was a trend for Age, $\chi 2(1) = 3.14$, $p = .074$; Story Type, $\chi 2(1) = 3.15$, $p = .076$, and the Story Type x Similarity interaction $\chi 2(1) = 2.91$, $p = .088$ to add to the model. The other factors did not predict internal details produced: Story Type x Age, $\chi 2(1) = 1.15$, $p = .28$; Similarity, $\chi 2(1) = 0.55$, $p = .46$, Similarity x Age, $\chi 2(1) = 0.08$, $p = .78$; Similarity x Story Type x Age, $\chi 2(1) = 0.09$, $p = .77$.

The data from Study 3 were submitted to the best fit model from Study 2 for the purpose of comparison. Random effects for the best fit model were $\sigma^2 = 1.06$, ICC = 0.42, $\tau_{00\ id} = 0.60$, $\tau_{00\ StoryNumber} = 0.16$. Marginal and Conditional R^2 for the model were 0.030 and 0.436, respectively. Replicating the direction of the effects in Study 2, this model revealed that age had a negative influence on the number of internal details produced (old: $M = 1.33$, $SE = .15$; young: $M = 1.57$, $SE = .15$), $B = -0.23$, $SE = 0.13$, $t(190.88) = 1.80$, 95% CI [-1.10, -0.06], as did story type (COVID: $M = 1.24$, $SE = .18$; everyday: $M = 1.66$, $SD = .18$), $B = -0.43$, $SE = 0.24$, $t(13.90) = 1.75$, 95% CI [-0.90, 0.05] (see Figure 3).

For external details, there was a correlation between the number of details produced within each participant (ICC = 0.34). Once again, story number was found to significantly predict the number of external details produced, $\chi 2(1) = 89.46$, $p < .001$; ICC = 0.43. Thus, both random effects were retained for the analysis. Only story type, $\chi 2(1) = 4.21$, $p = .04$ was a significant predictor of the number of external details produced and retained for the best fit model. The other factors did not significantly predict the number of external details produced: Age, $\chi 2(1) = 0.60$, $p = .44$, Story Type x Age, $\chi 2(1) = 2.40$, $p = .12$; Similarity, $\chi 2(1)= 2.56$, $p = .11$, Story Type x Similarity, $\chi 2(1) = 1.13$, $p = .29$, Similarity x Age, $\chi 2(1) = 0.23$, $p = .63$; Similarity x Story Type x Age, $\chi 2(1) = 0.00$, $p = .94$.

The best fit model revealed that the effect of story, $B = 0.45$, $SE = 0.21$, $t(9.32) = 2.13$, 95% *CI* [0.04, 0.87], was due to participants producing more external details in COVID-related ($M = 1.61$, $SE = .16$) than everyday scenarios ($M = 1.16$, $SE = .16$; see Figure 3). Random effects for the best fit model were $\sigma^2 = 1.20$, ICC = 0.41, $\tau_{00\ id} = 0.73$, $\tau_{00\ StoryNumber} = 0.12$. Marginal and Conditional R^2 for the model were 0.025 and 0.429, respectively.

Modeling the Effect of Condition on Willingness to Help Through Internal Details

In line with the findings of Study 2, we conducted a within-subjects mediation analysis to assess the role of internal details as a mediator between story type and willingness to help. Replicating the findings of Study 2, the indirect effect of story type on willingness to help via internal details produced was significant, effect = -.20, SE = .04, 95% *CI* (-.27, -.14), once again suggesting that COVID-related stories lower participants' willingness to help by lowering the number of internal details used to construct their imagined scenes.

Discussion

In Study 3, we again found that episodic simulation of helping increased willingness to help in both older and younger adults in both COVID-related and everyday scenarios. In this case, the relationship between willingness to help and participants' phenomenological experiences was largely similar between age groups. Finally, we replicated the finding that the effect of story on willingness to help is mediated by the number of internal details produced. Thus, COVID-related scenarios resulted in fewer episodic-like details which influenced participants' willingness to help.

General Discussion

The present study examined whether episodic simulation increases willingness to help in novel COVID-related situations and whether this is affected by age. Across three studies, we found that episodic simulation increased participants' willingness to help relative to a semantic control condition. This was true for both everyday and COVID-related scenarios. Despite older adults exhibiting higher a baseline level of willingness to help in Study 2 and a lower baseline in Study 3, episodic simulation was found to increase willingness to help in both age groups. Across all three studies, episodic simulation increased scene coherence and theory of mind, and in Studies 2 and 3 the same was true for emotional concern (see SI). In turn, these factors related to increased willingness to help, supporting previous work suggesting that these phenomenological experiences may be the mechanisms by which episodic simulation affects prosocial intentions (Gaesser et al., 2018; Sawczak et al., 2019). Studies 2 and 3 showed that people produce fewer internal details when imagining COVID-related scenarios, and Study 3 found that COVID-related scenarios resulted in more external details produced. Taken together, these findings suggest that we may rely less on episodic information and more heavily on external details (including semantic knowledge) when simulating events that are less similar to our previous experiences.

This is one of the first studies to explore episodic simulation of scenarios related to an on-going global crisis (cf., Sinclair et al., 2021, and commentary by Bulley & Schacter, 2021). Previous work that has explored simulation of unfamiliar scenarios has typically used hypothetical, often highly unlikely events (e.g., climbing Mount Everest; Arnold, McDermott, & Szpunar, 2011; de Vito et al., 2012; Wang et al., 2016) or manipulated scene familiarity by asking participants to imagine scenarios in either familiar or unfamiliar settings (Gaesser et al., 2018). Critically, the work here demonstrates that episodic simulation can be used to increase willingness to help in unfamiliar, real-world scenarios posed by the pandemic. Further, the present findings suggest that the underlying mechanisms involved in episodic simulation share considerable overlap in both familiar and unfamiliar scenarios (Gaesser et al., 2020). Specifically, we found that emotional concern, scene imagery, and subjective theory of mind are strong predicters of willingness to help in both everyday and COVID-related scenarios.

Nevertheless, we observed some differences between simulation of everyday and COVID-related scenarios. Across all three studies, subjective scene imagery was rated higher for COVID-related, compared to everyday scenarios. Despite everyday situations being more like those previously experienced by participants, higher scene imagery for COVID-related scenarios may reflect extensive media coverage of COVID-19.Relatedly, Study 3 revealed that when describing imagined COVID-related scenarios, participants produced more external details, which includes descriptions of tangential events, editorializing statements and semantic, rather than episodic, details (Levine et al., 2002). While it should be noted that participants received less time to describe their simulated events than is typically given in the lab, they still produced enough details to differentiate between conditions.[2] These findings support previous research that suggests that imagining familiar scenarios gives rise to more internal, episodic-like details, while novel scenarios rely more heavily on external details (de Vito et al., 2012; Wang et al., 2016). People also seem to rely more on semantic knowledge when episodic events are unavailable or impoverished (Devitt, Addis, & Schacter, 2017). While unfamiliar scenarios are typically found to be less vivid than familiar scenarios (Arnold, McDermott, & Szpunar, 2011; Gaesser et al., 2018; 2020), the increased external details and higher scene imagery ratings found here suggest that one can successfully construct a vivid, realistic scene, despite having few similar experiences on which to draw.

We expected the increased demand of simulating unfamiliar, COVID-related scenarios to lead to age differences. Contrary to our hypothesis, both younger and older adults exhibited a similar increase in willingness to help following episodic simulation, regardless of story type. These findings are in line with previous work examining episodic simulation in everyday scenarios across the lifespan (Gaesser et al., 2017; Sawczak et al., 2019). Indeed, while previous research has established age-related declines in episodic memory and simulation abilities (Addis et al., 2010; Addis et al., 2008), empathy and prosociality are thought to increase later in life (Carstensen, 2006; Mayr & Freund, 2020) and these may help to compensate for age-related deficits in simulation.

Practical Applications

[2] Moreover, they 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 in both Studies 2 and 3. Study 2: younger internal, $t(95) = 13.54$, $p<.001$; younger external, $t(95) = 11.23$, $p<.001$; older internal, $t(90) = 15.53$, $p<.001$; older external, $t(90) = 11.37$, $p<.001$. Study 3: younger internal, $t(94) = 14.97$, $p<.001$; younger external, $t(90) = 13.16$, $p<.001$; older internal, $t(101) = 17.97$, $p<.001$; older external, $t(101) = 14.90$, $p<.001$."

Simulation of potential future events makes them seem more plausible and increases the likelihood of actually engaging in the imagined behaviour (D'Argembeau & Jimenez, 2020). Thus, we suggest that similar tactics be used to encourage the general public to help those in need. Such strategies may be especially useful during difficult times when baseline willingness to help appears low. For instance, reporting styles could be tailored to encourage episodic simulation, wherein news stories ask their audiences to picture themselves giving aid to those in need or complying with health regulations. Fundraising events may also benefit from asking donors to take a moment, before donating, to picture themselves helping the person in need.

Limitations & Future Directions

A number of limitations should be discussed. First, the current studies did not include a debriefing questionnaire to assess potential demand characteristics. As such, it is possible that participants' willingness to help ratings and phenomenological experiences were influenced by their knowledge of experimenter expectations. However, because measures that were less obvious to participants (i.e., the production of internal and external details) were also influenced by the study manipulation, it seems unlikely that demand characteristics explain the entire effect in this case. Second, since the pandemic is a rapidly changing situation, it is difficult to control for fluctuations in case numbers and media exposure. To assess whether the evolving situation influenced our findings, we submitted the data from Studies 2 and 3 to a 2 (Condition: No-helping vs. Imagine Helping) X 2 (Story Type: Everyday vs. COVID-19) X 2 (Age: Younger vs. Older) mixed ANCOVA that included the 7-day average number of COVID-19 cases in the participants' province as a covariate in the model (see SI for results). The effect of condition on willingness to help was still observed, suggesting that fluctuations in COVID numbers cannot explain our results (relatedly, see SI for an analysis of COVID-related media consumption across studies 1-3).

Due to testing restrictions, the present studies were conducted online. While many in-lab findings have been replicated online, older adults tested online may be higher functioning and more computer savvy than those typically tested in the lab (Merz, Lace & Eisenstein, 2020). Moreover, across all three experiments, the mean age of our older adults was in the mid-60s, approximately 10 years younger than those previously tested in similar paradigms (Gaesser et al., 2017; Sawczak et al., 2019). Indeed, the current samples may represent a younger cohort of older adults, which may help explain the lack of age difference.

In conclusion, the present studies suggest that episodic simulation of helping can increase willingness to help in unprecedented scenarios posed by the COVID-19 pandemic. Age-related declines in episodic simulation may not translate to willingness to help paradigms given older adults' increased prosocial and emotional goals, however further research is needed to determine whether the boost to willingness to help relies on different mechanisms across the lifespan. Nevertheless, the present work suggests that encouraging the wider public to imagine themselves helping others may encourage prosocial behaviour as we move forward and heal from the global effects of the COVID-19 pandemic.

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Supplementary Procedure

Scenario List

COVID-Related Scenarios

- This single parent is a health care worker and has to work during the pandemic. No one is available to watch their children.
- This person is considered a high-risk individual, but their family members are not engaging in social distancing.
- This person's roommate keeps hosting parties despite the on-going pandemic.
- This person has recently been tested for COVID-19. They are lost in the downtown area.
- This person requires at-home oxygen to help with their COVID-19 treatment. They are unable to walk to their mailbox.
- This person posts on social media that they are completely out of essentials (like toilet paper and hand soap) due to panic buying.

Everyday Scenarios

- This person is locked out of their house.
- This person's car has broken down on the side of the road. They have no way home.
- This person is going door-to-door asking for non-perishable food items.
- This person is being harassed on the train by other passengers.
- This person appears to have dementia and is wandering aimlessly on the street.
- This person is out of breath and coughing on a hiking trail. They appear to be having an asthma attack.

Study 2:

Imagined Scenario Transcript Examples

Younger Adults

1. I would use online sources to help them find somewhere to stay. Find locations, help call leads, help pack their stuff. I have a vehicle so I could help move items if needed.
2. I would go talk to them to see if they could tell mee anything and if not I would call maybe the hospital or take them there…
3. I would donate any extra supplies I have, as long as I could verify that I wasn't being scammed.
4. I would help this person report their roommate. Inform their roommate in how this pandemic will keep going if you keep doing this.

Older Adults

1. I would see what I have in my house and give them something that was non-perishable. I would feel sad for that person and want to help.
2. If I had extra, I would be willing to share with them and hope that others would as well. I have had trouble getting essentials as well and could not afford…
3. Call for help immediately, hopefully you have a cell phone to help them, most people hiking have a cell or unit to contact someone if you find…
4. I would not. There are just too many scammer and hustlers pretending to be in need around this town. I wouldn't even answer the door and I might call the cops to report them.

Supplementary Results

Study 1:

Effects of Episodic Simulation on Phenomenological Experiences

To test whether episodic simulation, story type and age influenced these phenomenological measures, each measure was submitted to a separate 2 (Condition: No-helping vs. Imagine Helping) X 2 (Story Type: Everyday vs. COVID-19) X 2 (Age: Younger vs. Older Adults) mixed ANOVA.

For the emotional concern index, there was a main effect of age, F (1, 198) = 7.35, p = .007, $\eta p^2 = 0.036$, reflecting older adults' (M = 4.33, SE = 0.09) higher emotional concern compared to younger adults (M = 3.96, SE = 0.12). None of the other main effects or interactions were significant, p's > .066.

For scene imagery index, there was a main effect of condition, F (1, 198) = 13.89, p < .001, $\eta p^2 = 0.066$, reflecting greater scene imagery ratings in the episodic simulation (M = 4.07, SE = .09) compared to judging journalistic style condition (M = 3.91, SE = .10). We also found a main effect of story type, F (1, 198) = 8.14, p = .005, $\eta p^2 = 0.039$, such that scene imagery was greater in the COVID-related (M = 4.05, SE = .10) compared to everyday scenarios (M = 3.94, SE = 10). Further, there was an interaction between condition and story, F (1, 198) = 6.46, p = .012, $\eta p^2 = 0.032$, suggesting that the effect of condition on scene imagery differed across story types. Follow-up t-tests revealed that scene imagery was higher after episodic simulation of everyday scenarios (M = 4.03, SE = .10) compared to judging journalistic style (M = 3.73, SE = .11), t (199) = 4.12, p < .001. Conversely, for COVID-related stories, scene imagery did not increase after episodic simulation (M = 4.05, SE = .10) compared to judging journalistic style (M

= 4.00, *SE* = .10), *t* (199) = 0.91, *p* = .365. Furthermore, t-tests revealed that baseline scene imagery was higher for COVID-related compared to everyday scenarios, *t* (199) = 3.60, $p < .001$, but there was no difference in scene imagery across stories following episodic simulation, *t* (199) = 0.32, *p* = .747. None of the other main effects or interactions were significant in the mixed ANOVA, *p*'s > .183.

For subjective theory of mind, our mixed ANOVA revealed a main effect of condition, *F* (1, 198) = 9.30, *p* = .003, $\eta p^2 = 0.045$, reflecting greater consideration of the thoughts and feelings of the person in need after episodic simulation (*M* = 5.07, *SE* = .08) compared to judging journalistic style (*M* = 4.95, *SE* = .07). There was also a main effect of story, *F* (1, 198) = 5.62, *p* = .019, $\eta p^2 = 0.028$, reflecting greater consideration of the thoughts and feelings of the person in need in everyday (*M* = 5.11, *SE* = .08) compared to COVID-related scenarios (*M* = 4.91, *SE* = .08). We also found a main effect of age, *F* (1, 198) = 15.12, $p < .001$, $\eta p^2 = 0.071$, driven by older adults' higher (*M* = 5.27, *SE* = .08) consideration for the thoughts and feelings of the person in need compared to younger adults (*M* = 4.75, *SE* = .12). Further, there was an interaction between story and age, *F* (1, 198) = 7.45, *p* = .007, $\eta p^2 = 0.036$, suggesting that subjective theory of mind differs for younger and older adults across story types. Follow-up t-tests revealed that older adults' subjective theory of mind was higher for everyday (*M* = 5.43, *SE* = .08) compared to COVID-related scenarios (*M* = 5.10, *SE* = .10), *t* (99) = 4.34, $p < .001$. Conversely, younger adults' subjective theory of mind did not differ between everyday (*M* = 4.78, *SE* = .12) and COVID-related scenarios (*M* = 4.71, *SE* = .13), *t* (99) = 0.88, *p* = .379. None of the other interactions in the mixed ANOVA were significant, *p*'s > .068.

Study 2:

Willingness to Help by Condition and Story Manipulation with Safety Ratings as a Random Factor

To assess whether participants' ratings of how safe it is to help in each story influenced the best fit model generated for Study 2, the same model was reproduced with the addition of safety ratings as a random factor. Replicating the main analysis from Study 2, best fit model estimates indicate that there was an effect of Condition, $B = 0.42$, $SE = 0.08$, $t(1715) = 4.94$, 95% CI [0.24, 0.58], such that willingness to help was higher following episodic simulation of helping relative to judging journalistic style (see Figure 2 for observed means). As with the findings of the main analysis, we found an interaction between condition and age which was explained by older adults' higher willingness to help in the journalism condition, $B = 0.37$, $SE = 0.17$, $t(265.4)= 2.25$, 95% CI [0.05, 0.70], but not in the episodic simulation condition, $B = 0.10$, $SE = 0.16$, $t(228.6) = 0.60$, 95% CI [-0.22, 0.41]. Thus, the addition of participant safety ratings as a random factor did not change the overall findings of the best fit model.

Table 2.S1

Best fit model for Willingness to Help – Study 2 with safety ratings as a random factor

	Study 2 – Willingness to Help		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	4.46	3.88 – 5.03	**<0.001**
Condition	0.42	0.25 – 0.58	**<0.001**
OA x No Helping	0.37	0.05 – 0.70	**0.024**
OA x Imagine Helping	0.10	-0.22 – 0.41	0.550
Random Effects			
σ^2	1.81		
$\tau_{00\ id}$	1.09		

τ_{00} StoryNumber	0.40
τ_{00} safety	0.34
ICC	0.48
N id	187
N StoryNumber	12
N Safety	7
Observations	1897
Marginal R^2 / Conditional R^2	0.011 / 0.485

Note: Reference groups for contrasts were the Journalism Condition, and Younger Adults

Effects of Episodic Simulation on Phenomenological Experiences

In keeping with Study 1, emotion scales were averaged to form an emotional concern index, and ratings of scene coherence and detail were averaged to form a scene imagery index. To test whether episodic simulation, story type and age influenced participants' phenomenological experiences, we conducted separate 2 (Condition: No-helping vs. Imagine Helping) X 2 (Story Type: Everyday vs. COVID-19) X 2 (Age: Younger vs. Older Adults) mixed ANOVAs on emotional concern, scene imagery, and subjective theory of mind.

For the emotional concern index, our mixed ANOVA revealed a main effect of condition, F (1, 167) = 20.25, p <.001, ηp^2 = 0.108, reflecting higher emotional concern after episodic simulation (M = 4.22, SE = .09) compared to when judging journalistic style (M = 3.96, SE = .10). There was also an interaction between condition and age, F (1, 167) = 4.33, p =.039, ηp^2 = 0.025, suggesting that the effect of condition on emotional concern differed in younger and older adults. Follow-up t-tests revealed that older adults exhibited greater emotional concern after episodic simulation (M = 4.42, SE = .11) compared to younger adults (M = 4.07, SE = .12), t (185) = 2.11, p = .037. When judging the journalistic style, there was no difference in emotional concern between older (M = 4.12, SE = .13) and younger adults (M = 3.94, SE = .13), t (185) = 0.90, p = .317. None of the other main effects or interactions were significant, p's > .126.

For the scene imagery index, our mixed ANOVA revealed a main effect of condition, F (1, 167) = 21.42, p <.001, $\eta p^2 = 0.114$, reflecting participants' higher scene imagery ratings after episodic simulation, (M = 4.09, SE = .11) compared to when judging journalistic style (M = 3.78, SE = .11). There was also a main effect of story, F (1, 167) = 18.33, p <.001, $\eta p^2 = 0.099$, reflecting higher scene imagery in COVID-related (M = 4.05, SE = .11) compared to everyday stories (M = 3.85, SE = 11). None of the other main effects or interactions were significant, p's > .132.

Finally, for subjective theory of mind, our mixed ANOVA revealed a main effect of condition, F (1, 167) = 7.94, p =.005, $\eta p^2 = 0.045$, reflecting participants' higher consideration of the thoughts and feelings of the person in need after episodic simulation (M = 5.08, SE = .09) compared to when judging journalistic style (M = 4.92, SE = .10). None of the other main effects or interactions were significant, p's > .195.

ANCOVA Controlling for COVID Case Numbers

To assess whether shifts in COVID case numbers influenced our findings, we conducted a 2 (Condition: No-helping vs. Imagine Helping) X 2 (Story Type: Everyday vs. COVID-19) X 2 (Age: Younger vs. Older Adults) mixed ANCOVA on participants' willingness to help, controlling for the 7-day average number of COVID-19 case numbers as a covariate in the model. Case numbers were obtained from the CBC News Coronavirus Tracker. Our analysis revealed a main effect of condition, F (1, 166) = 6.03, p = .015, ηp2 = 0.035 wherein participants reported an increased willingness to help after episodic simulation (M = 5.00, SE = .093) compared to when judging journalistic style (M = 4.68, SE = .100). Our analysis also revealed a main effect of story, *F* (1, 166) = 12.02, *p* <. 001., ηp2 = 0.068, such that willingness to help was higher in the everyday (*M* = 5.10, SE = .09) compared to the COVID-related scenarios (*M* = 4.58, SE = .10). There were no other significant main effects or interactions in the ANCOVA, *p*'s > .152.

Study 3:

Willingness to Help by Condition and Story Manipulation with Safety Ratings as a Random Factor

To assess whether participants' ratings of how safe it is to help in each story influenced the best fit model generated for Study 3, the same model was reproduced with the addition of safety ratings as a random factor.

Table 2.S2

Best fit model for Willingness to Help - Study 3 with safety ratings as a random factor

	Study 3 – Willingness to Help		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	4.65	4.20 – 5.10	**<0.001**
Condition	0.31	0.14 – 0.48	**<0.001**
OA – No Helping	-0.30	-0.63 – 0.03	0.077
OA – Imagine Helping	-0.01	-0.33 – 0.30	0.929
Random Effects			

σ^2	1.74
$\tau_{00\ Id}$	0.96
$\tau_{00\ StoryNumber}$	0.30
$\tau_{00\ Safety}$	0.45
ICC	0.50
N_{Id}	192
$N_{StoryNumber}$	12
N_{Safety}	7
Observations	1933
Marginal R^2 / Conditional R^2	0.017 / 0.504

Note: Reference groups for contrasts were the Journalism Condition, and Younger Adults

Replicating the main analysis from Study 3, best fit model estimates indicate that there was an effect of Condition, $B = 0.31$, $SE = 0.09$, $t(1744) = 3.50$, 95% CI [0.14, 0.48], such that willingness to help was higher following episodic simulation of helping relative to judging journalistic style (see Figure 2 for observed means). Similarly, there was a trend for older adults to report lower willingness to help than younger adults in the journalism condition, $B = -0.30$, $SE = 0.17$, $t(272.31)= 1.77$, 95% CI [-0.63, 0.03], but not in the episodic simulation condition, $B = -0.01$, $SE = 0.16$, $t(233.23) = 0.16$, 95% CI [-0.33, 0.30]. Thus, the addition of safety ratings as a random factor did not significantly change the findings of best fit model.

Effects of Episodic Simulation on Phenomenological Experiences

In keeping with Studies 1 and 2, emotion scales were averaged to form an emotional concern index, and ratings of scene coherence and detail were averaged to form a scene imagery index. To test whether episodic simulation, story type and age influenced participants' phenomenological experiences, we conducted separate 2 (Condition: No-helping vs. Imagine Helping) X 2 (Story Type: Everyday vs. COVID-19) X 2 (Age: Younger vs. Older Adults) mixed ANOVAs on emotional concern, scene imagery, and subjective theory of mind.

For the emotional concern index, our mixed ANOVA revealed a main effect of condition, F (1, 162) = 16.01, p <.001, $\eta p^2 = 0.090$, reflecting higher emotional concern after episodic simulation (M = 4.16, SE = .09) compared to when judging journalistic style (M = 3.87, SE = .09). None of the other main effects or interactions were significant, p's > .133.

For the scene imagery index, our mixed ANOVA revealed a main effect of condition, F (1, 162) = 24.16, p <.001, $\eta p^2 = 0.130$, which was driven by higher scene imagery after episodic simulation (M = 3.85, SE = .11) compared to judging journalistic style (M = 3.44, SE = .11). There was also a main effect of story, F (1, 162) = 5.30, p =.023, $\eta p^2 = 0.032$, such that participants reported higher scene imagery in COVID-related (M = 3.73, SE = .11) compared to everyday stories (M = 3.56, SE = .11). None of the other main effects or interactions were significant, p's > .065.

For subjective theory of mind, our mixed ANOVA revealed a main effect of condition, F (1, 162) = 39.24, p <.001, $\eta p^2 = 0.195$, reflecting greater consideration of the thoughts and feelings of the person in need following episodic simulation (M = 5.16, SE = .09) compared to judging journalistic style (M = 4.67, SE = .10). We also found a main effect of story, F (1, 162) = 18.79, p <.001, $\eta p^2 = 0.104$, reflecting greater consideration of the thoughts and feelings of the person in need in everyday (M = 5.14, SE = .09) compared to COVID-related scenarios (M = 4.78, SE = .09). Further, there was an interaction between condition and age, F (1, 162) = 6.99, p =.009, $\eta p^2 = 0.041$, suggesting that the effect of condition on subjective theory of mind differed across age groups. Follow-up t-tests revealed that younger adults exhibited an increase in subjective theory of mind after imagining helping (*M* = 5.10, *SE* = .13) relative to judging journalistic style (*M* = 4.82, *SE* = .14) of the stories, *t* (94) = 3.29, *p* = .001. Similarly, older adults also exhibited an increase in subjective theory of mind after imagining helping (*M* = 5.22, *SE* = .12) relative to judging journalistic style (*M* = 4.53, *SE* = .15) of the stories, *t* (101) = 6.42, *p* < .001. Thus, while episodic simulation increased consideration of the thoughts and feelings of the person in need in both age groups, older adults exhibited a greater difference between conditions. None of the other main effects or interactions were significant, *p*'s > .529.

ANCOVA Controlling for COVID Case Numbers

To assess whether shifts in COVID case numbers influenced our findings, we conducted a 2 (Condition: No-helping vs. Imagine Helping) X 2 (Story Type: Everyday vs. COVID-19) X 2 (Age: Younger vs. Older Adults) mixed ANCOVA on participants' willingness to help, controlling for the 7-day average number of COVID-19 case numbers as a covariate in the model. Case numbers were obtained from the CBC News Coronavirus Tracker. Our analysis revealed a main effect of condition, F (1, 161) = 15.75, *p* < .001, ηp2 = 0.089 wherein participants reported an increased willingness to help after episodic simulation (M = 4.96, SE = .098) compared to when judging journalistic style (M = 4.38, SE = .110). Our analysis also revealed a main effect of story, F (1, 161) = 20.91, *p* <. 001., ηp2 = 0.115, such that willingness to help was higher in the everyday (M = 4.95, SE = .10) compared to the COVID-related scenarios (M = 4.39, SE = .10). There was also a significant interaction between condition and age, F (1, 161) = 4.82, *p* = .030, ηp2 = 0.029. Follow-up t-tests revealed that the interaction was driven by younger adults' (M = 4.61, SE = .14) greater willingness to help than older adults (M = 4.20, SE = .15) in the no-helping condition, t (195) = 1.98, *p* = .049. There were no other significant main effects in the ANCOVA, *p*'s > .125.

COVID Information Consumption Across Studies 1-3

The amount of COVID-related information consumed by participants was measured by asking participants to rate statements such as "I watch news on COVID topics", "I read about COVID-19 (the novel coronavirus)" from 1-never to 5-often. To test whether this changed across Studies 1-3 and should be considered in our analyses, we conducted a separate 3 (Study Number: 1 vs 2 vs 3) X 2 (Age: Younger vs. Older Adults) ANOVA on participants' average ratings of such statements. The analysis revealed a main effect of age, F (1, 582) = 13.95, p <.001, ηp^2 = 0.023, reflecting younger adults' (M = 2.58, SE = 0.04) higher ratings of information consumption compared to older adults (M = 2.39, SE = 0.04). None of the other main effects were significant, p's > .393.

Younger adults' higher ratings of consuming COVID-related news topics in the current project is in line with recent work on their use of the internet for Health Information Seeking Behaviours related to COVID-19 (Beaudoin & Hong, 2021). In terms of whether this difference in media consumption may influence our age-related hypothesis, we might expect that younger adults would rate COVID scenarios as being more vivid, given that their greater media consumption gives them more to draw on. However, across all three studies, COVID-related scenarios were rated as more vivid than everyday scenarios, but, importantly, there was no effect of age on vividness ratings. As such, while younger adults may be consuming more COVID-related media, it does not translate to an increase in participants' subjective vividness ratings of these scenarios and thus is unlikely to influence willingness to help in the current studies. Instead, younger adults' higher rate of consumption may reflect their greater media use overall.

Supplementary Figures

Figure 2.S1.

Scatter plots displaying the repeated measures correlations between willingness to help and phenomenological experiences in Study 1.

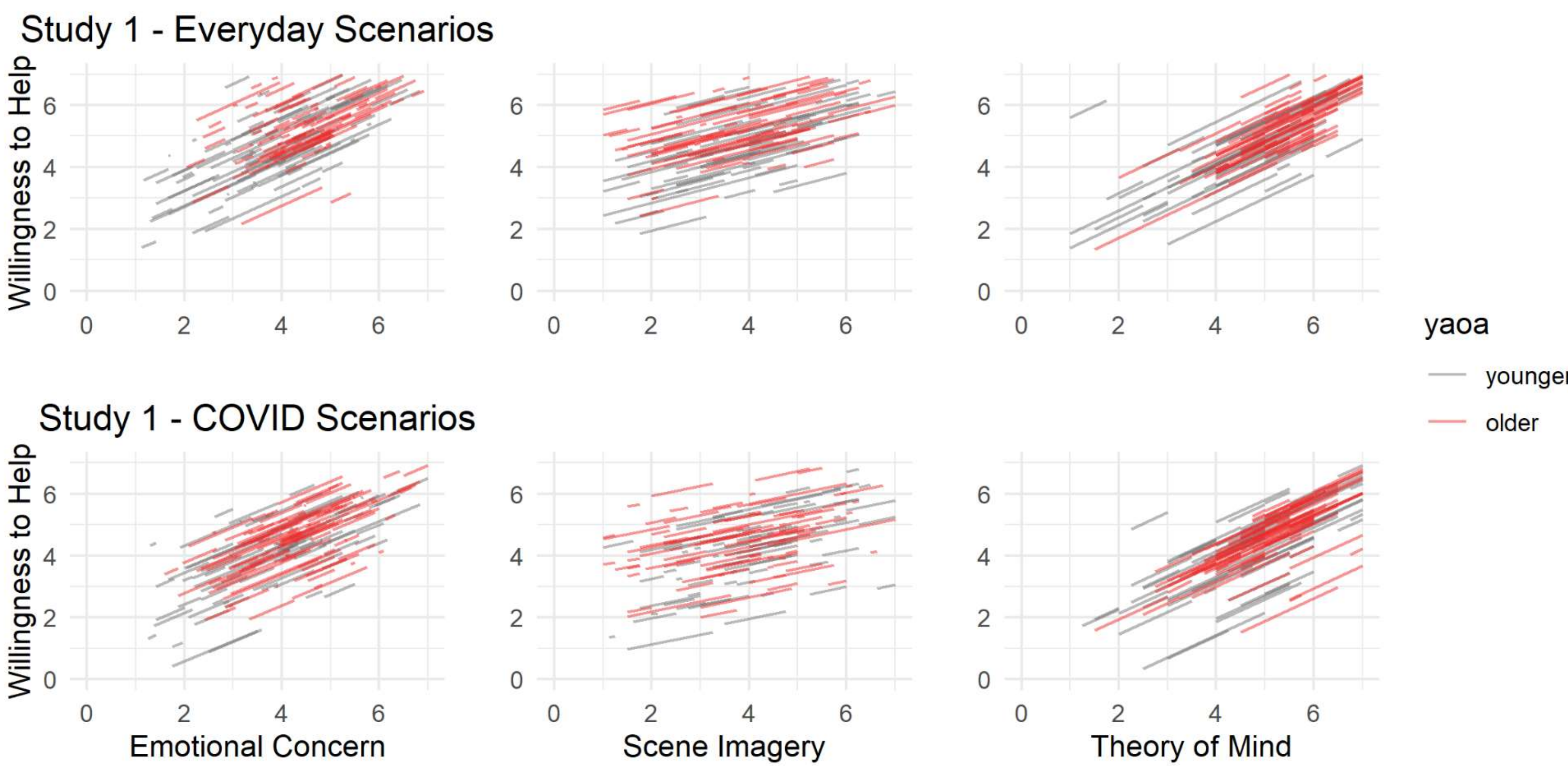


Figure 2.S2.

Scatter plots displaying the repeated measures correlations between willingness to help and phenomenological experiences in Study 2.

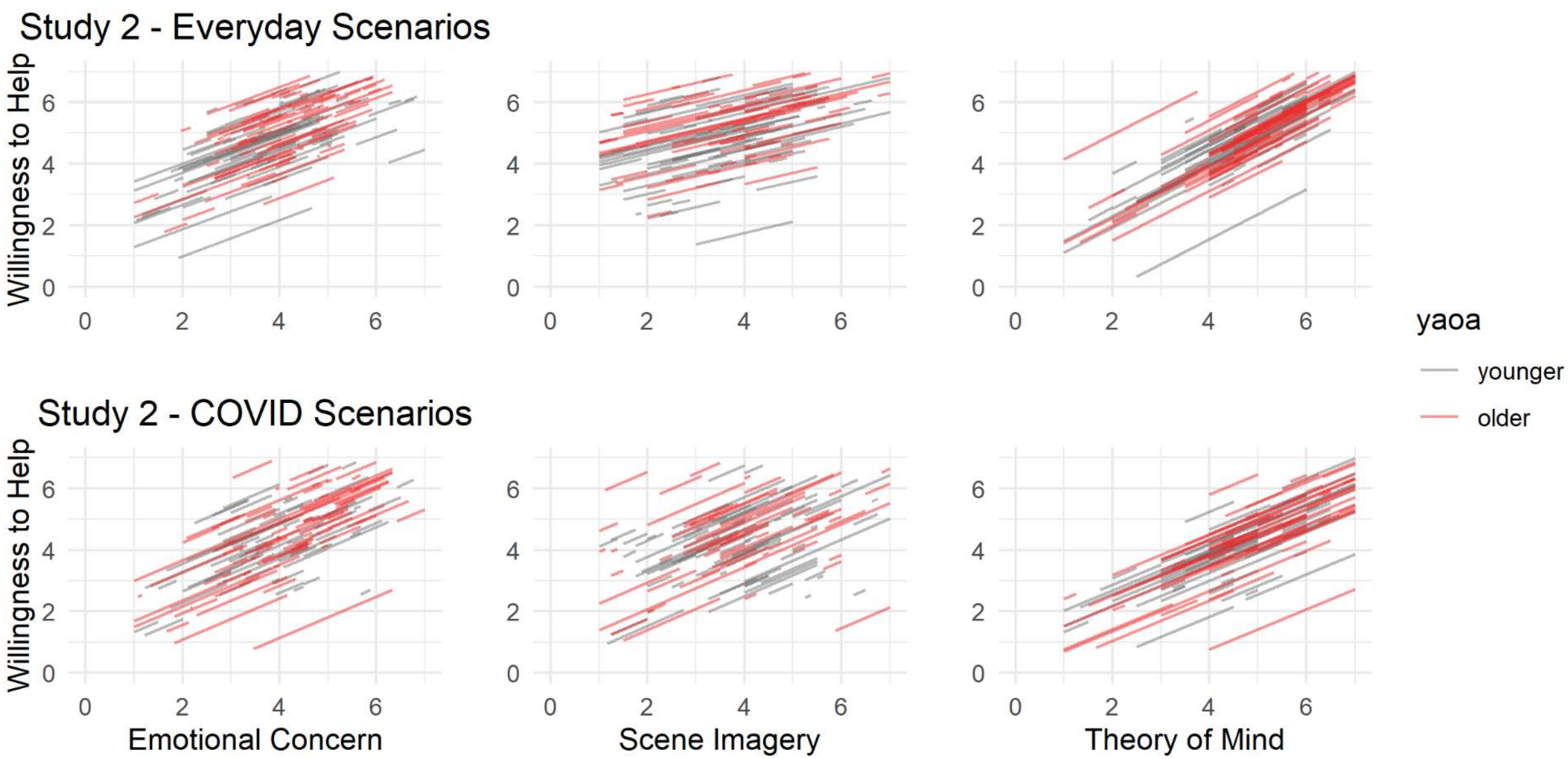
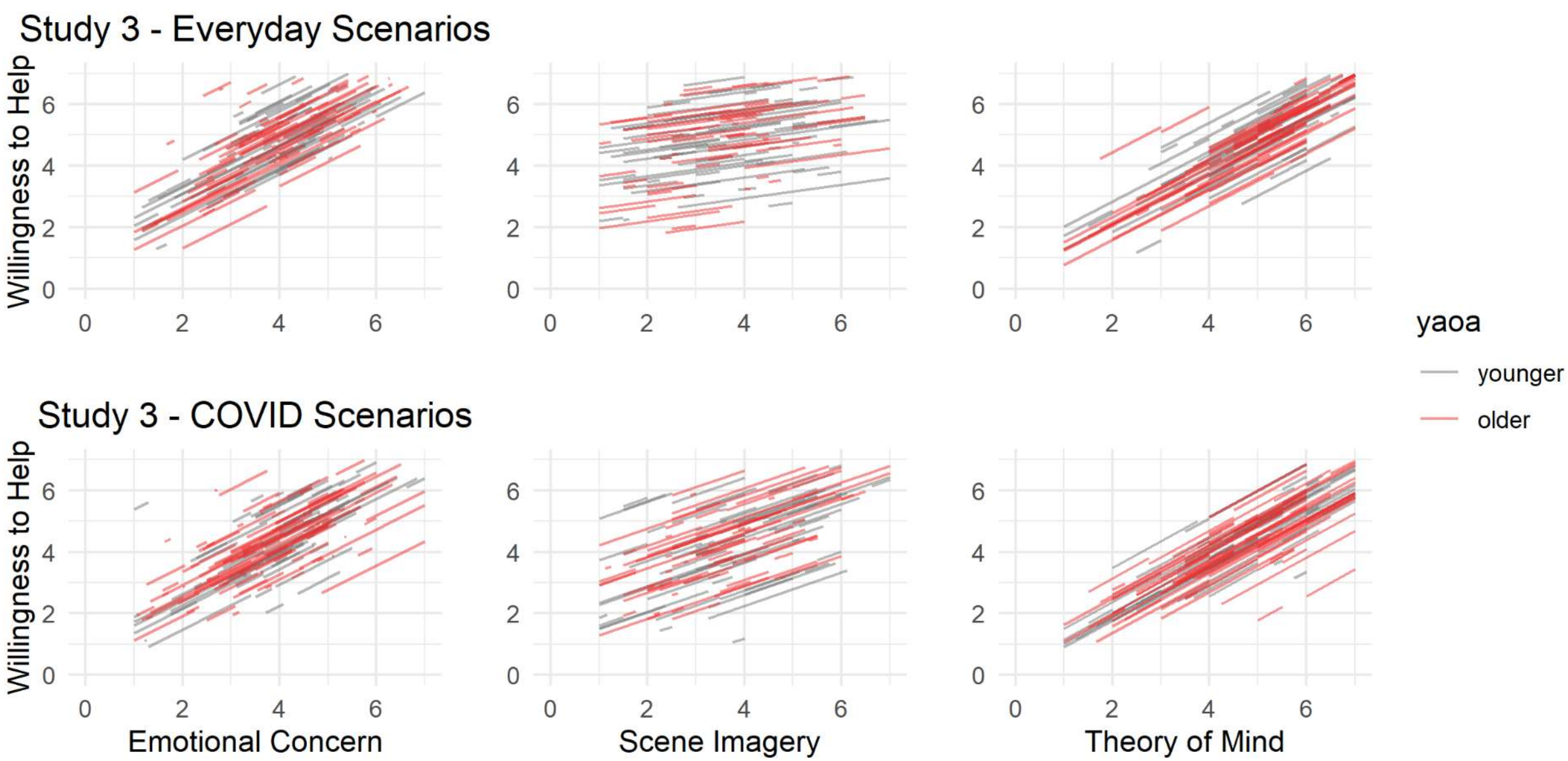


Figure 2.S3.

Scatter plots displaying the repeated measures correlations between willingness to help and phenomenological experiences in Study 3.



Chapter 3: Effect of situation similarity on younger and older adults' episodic simulation of helping behaviours

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Abstract

Similar cognitive processes enable us to remember the past (i.e., episodic memory) and simulate future events (i.e., episodic simulation). In the current study, we demonstrate an important role for previous experience when younger and older adults simulate future behaviours. Participants read short descriptions of a person in need of help in scenarios that were more familiar to either younger or older adults (e.g., dealing with dating apps vs writing a cheque). Participants either imagined helping the person or thought about the style of the story (control task), and then rated their willingness to help, scene vividness, emotional concern, and subjective use of theory of mind. Hierarchical mixed effect modelling revealed that both episodic simulation and one's previous experience increased willingness to help, in that participants were more willing to help if they imagined helping and the situation was more familiar to them. Further, in simulated scenarios the relationship between previous experience and willingness to help was mediated by scene vividness and perspective-taking in younger adults, but only by perspective-taking in older adults. Taken together, these findings suggest that situation similarity and episodic simulation increase willingness to help, possibly via different mechanisms in younger and older adults.

Keywords: episodic simulation, aging, scene vividness, perspective-taking, helping behavior

As we engage with the world around us, we spend a considerable amount of time thinking about hypothetical scenarios. These would-be scenarios (i.e., episodic simulations) are crucial in our day-to-day lives as they enable us to plan for the future, make decisions, and solve problems [1,2]. According to the *constructive episodic simulation hypothesis,* we draw on previous experience (i.e., episodic memory) and flexibly recombine details from these events to simulate possible future events [1,2,4]. These vivid, sensory-rich imagined scenes largely rely on the same set of brain regions that are active when remembering the past, including the hippocampus, medial prefrontal cortex, lateral temporal cortices, and posterior cingulate cortex (often referred to as the default mode network) [3-6]. Moreover, damage to the medial temporal lobe has been shown to similarly affect both episodic memory for the past and one's ability to imagine the future [7,8], suggesting a link between the two processes.

Another line of evidence that supports the link between episodic memory and simulation is the finding that both abilities are similarly affected by age [9,10]. Compared to younger adults, older adults produce fewer rich, episodic details and more general, semantic details both when remembering the past and imagining future events [10,11]. Furthermore, older adults report less of a sense of re-living the past and pre-living the future when reconstructing past and imagining future events, [12], suggesting an impaired retrieval process that affects both memory and simulation [11, 13]. Similar deficits have also been identified in higher-order tasks that require the use of episodic simulation [14-16]. For instance, when asked to generate solutions to a series of problems with predetermined outcomes (i.e., means-end problem solving), older adults produce fewer episodic-like details and this deficit is linked to the generation of fewer relevant solutions to the problems compared to younger adults [14].

However, these findings are somewhat at odds with a growing body of research demonstrating that episodic simulation of helping behaviour (i.e., imagining helping others – another task that requires problem-solving) similarly increases willingness to help in younger and older adults [17-19]. For instance, both cohorts exhibit greater willingness to help after imagining themselves helping a person in need, relative to a semantic control task [17, 18]. This effect is thought to stem from the fact that episodic simulation can make events seem more plausible and ultimately, shape one's intentions and subsequent behaviour [2, 20-23]. Moreover, in addition to increasing one's prosocial intentions, imagining future helping scenarios also increases participants' ratings of scene vividness similarly in both younger and older adults, as well as the degree to which they consider the thoughts and feelings of the person in need [17-19]. These phenomenological experiences are thought to mediate the effect of episodic simulation on willingness to help, in that imagining helping increases emotional concern for the person in need and vividness of the imagined scene, which in turn contribute to an increased intention to help [17-19].

If older adults have impaired access to episodic memory, yet they exhibit changes in willingness to help following episodic simulation, it may be that older adults' increased willingness to help arises via different mechanisms than younger adults. However, findings in this area are mixed and often at odds. For instance, Gaesser et al. [17] showed that while subjective scene vividness similarly predicts willingness to help in both older and young adults, there was a trend for a stronger relationship between willingness to help and theory of mind in younger adults. Moreover, when they controlled for participants' emotional concern for the person in need, the effect of episodic simulation on older adults' willingness to help was eliminated, suggesting that their increased willingness to help is simply a result of increased emotional concern [12]. Another study using a similar paradigm found that episodic simulation increased empathic concern (i.e., the extent to which the scenario made them feel compassion, warmth, sympathy, and tenderness) to a greater degree in younger (compared to older) adults, possibly because older adults exhibited higher baseline levels of empathic concern [18]. Nevertheless, older adults exhibited an increase in willingness to help that was comparable to younger adults [18], highlighting the need for further clarification as to whether the mechanisms of episodic simulation differ between young and older adults.

The Role of Previous Experience on Future Simulations

Given the importance of episodic memory and scene vividness on future simulations, it is important to consider how one's previous experience with the situation may affect one's ability to imagine future helping scenarios. Indeed, events simulated in familiar, compared to unfamiliar, locations are reported as being clearer [24]. Moreover, young adults have been shown to produce more semantic-like details when imagining unfamiliar events [25], and this work has recently been extended to older adults [19]. In a recent series of experiments, Ryan et al. [19] examined whether episodic simulation could increase younger and older adults' willingness to help in unfamiliar scenarios posed by the COVID-19 pandemic. Participants read a series of short scenarios, half of which depicted people in need in everyday situations, and half depicted COVID-related problems. Notably, data for this project was collected in the early days the pandemic, when COVID was largely unfamiliar. Results showed that imagining helping a person in need increased younger and older adults' willingness to help in both everyday and COVID-related scenarios, though participants were less willing to help overall in the less familiar (and potentially riskier) COVID scenarios. Moreover, both groups produced more semantic-like details when imagining COVID-related scenarios, suggesting that people may need to draw on more semantic knowledge than personal experience to simulate unfamiliar scenarios.

The Current Study

While Ryan et al. [19] showed that both older and younger adults can simulate helping in novel COVID-related scenarios, the more familiar "everyday" scenarios used in that study were ones previously developed *by* young-adult researchers *for* young-adult participants [23]. Beyond pure memory abilities, the type of stimuli to be remembered or simulated likely plays a role in whether age differences in memory or future simulation are observed [26, 27]. It is possible that age differences in episodic simulation may be even less pronounced if using problem scenarios developed with and tailored for each group. Furthermore, COVID-related scenarios also differed from everyday scenarios in terms of the threat posed by the contagion and concerns about social distancing. Thus, the goal of the current study was to test whether manipulating each age group's familiarity with more typical problem scenarios would affect their ability to simulate the event and, as a result, their willingness to help. Much of the research examining episodic simulation of unfamiliar scenarios has manipulated scene familiarity by asking participants to imagine scenarios occurring at either familiar or unfamiliar settings [28]. Thus, in many cases, research examining episodic simulation of familiar and unfamiliar events requires participants to imagine events occurring under largely improbable conditions (e.g., climbing Mount Everest) [24-25, 30], which may be especially implausible to older adults. Furthermore, research examining older adults' ability to imagine unfamiliar scenarios is limited, and extant research suggests that both younger and older adults experience more subjective detail in events imagined in more familiar spatial contextual cues (i.e., familiar landmarks [28]).

To determine which scenarios were most/least familiar to older and younger adults, we first consulted with each age group to develop a list of scenarios potentially familiar to each cohort. We then ran a pilot study in which older and younger adults rated their familiarity with each scenario. Twelve scenarios that showed a large difference in familiarity between younger and older adults (6 younger-familiar, 6 older-familiar) were selected for the main experiment. In this experiment, participants read a series of problem scenarios and were instructed to either imagine themselves helping the person in need, or to judge the journalistic source and style of the story. For each story, participants rated their willingness to help the person in need and their phenomenological experiences (i.e., scene vividness, perspective-taking, and emotional concern).

We expected both older and younger adults to show increased willingness to help following episodic simulation relative to the journalistic style condition. Further, given the role of episodic memory in future simulations, we expected this effect to be moderated by similarity ratings (i.e., a greater increase in willingness to help for scenarios that were rated as more similar to one's previous experiences). We also expected higher similarity ratings to be related to higher ratings of scene vividness, as these are scenarios for which participants likely have memories [31]. Moreover, previous work using the current paradigm has demonstrated that scene vividness may be a mechanism through which episodic simulation influences willingness to help [17-19, 23, 28]. Thus, we expected an indirect relationship between story similarity (to one's personal experience) and willingness to help via scene vividness, such that increased situation similarity increases the vividness of a scene in one's mind, which in turn increases one's willingness to help. Finally, given well-established age differences in episodic memory, we expected age to moderate the path between similarity and scene vividness, such that older adults should exhibit a reduced relationship between previous event similarity and scene vividness.

Methods

Scenario Pilot

To ensure the stimuli used in our experiment contained topics that were both familiar and unfamiliar to younger and older adult, we piloted 40 potential scenario topics in an online study run using the Qualtrics' Research Panel. Participants included 67 younger (M = 28.36, SD = 4.99, range = 18-35) and 68 older (M = 70.25, SD = 4.33, range = 60-80) Canadian residents. Among younger adults, 45.6% self-identified as White, Caucasian, or European, 23.5% as Asian, 5.9% as Canadian (including French Canadian), 5.9% as Middle Eastern, 4.4% as Black, African American/Canadian or African, 4.4% as Indian (including South India), 1.5% as mixed ethnicity, 1.5% as Hispanic or Latin American, 1.5% as Native American, and 5.9% as unknown or refused to answer. Among older adults, 67.6% self-identified as White, Caucasian, or European, 22.1% as Canadian (including French Canadian), 5.9% as Asian, 1.5% as Indian (including South India), 1.5% as Native American, and 1.5% as unknown or refused to answer.

The piloted scenarios included those used in previous research [28] as well as scenarios created in consultation with younger and older adults. Participants rated each scenario topic on how familiar it was (1 unfamiliar – 7 very familiar), how similar it was to events they had experienced in the past (1 not at all – 7 very similar), and then completed a brief demographic questionnaire. We selected the 6 stories rated most familiar and similar to events experienced by younger and older adults (12 stories total, provided in the Supplementary Information). The selected stories were then divided into lists of young-familiar and old-familiar stimuli that differed significantly between age groups in terms of similarity, $t_{older\text{-}familiar}(134) = 3.80$, $p < .001$, $t_{younger\text{-}familiar}(134) = 6.81$, $p < .001$, and familiarity, $t_{older\text{-}familiar}(134) = 3.20$, $p = .002$, $t_{younger\text{-}familiar}(134) = 5.74$, $p < .001$, (see Table 3.1 for scenario list means). Raw participant ratings of all 40 scenarios as well as their demographics are available at

(https://osf.io/wzgvf/?view_only=136eccd317104423be4d77a18cfbab61).

Table 3.1

Participant ratings of scenario lists by age

Scenario List	Ratings			
	Similarity		Familiarity	
Pilot data	YA	OA	YA	OA
Younger-Familiar	3.79 (1.55)	2.19 (1.16)	3.95 (1.64)	2.45 (1.40)
Older – Familiar	3.84 (1.43)	4.77 (1.44)	4.07 (1.52)	4.98 (1.47)
Main experiment				
Younger-Familiar	3.73 (1.52)	2.51 (1.36)	4.26 (1.48)	3.19 (1.52)
Older-Familiar	3.54 (1.55)	3.68 (1.46)	3.87 (1.52)	4.32 (1.41)

Note: Standard deviation in parentheses.

Main Experiment Participants

We aimed to test the same number of participants as our previous study using a similar paradigm [19]: 100 younger (18-35 years) and 100 older (60-80 years) adults. Participants were recruited through the Qualtrics' Research Panel and included both Canadian and American residents. All participants reported 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, 223 participants completed the study, and 7 study responses were removed due to having duplicate IP addresses. A further 21 participants were removed for having too few correctly performed trials (see below). Finally, 12 older and 9 younger adults were removed due to poor performance on the adapted version of the Mini-Mental State Exam (MMSE) [34].

Participants' open-ended responses were used to assess whether each trial was completed correctly. Incorrect trials were defined as those in which participants explicitly mentioned performing the opposite task (e.g., judging the journalistic style of a story when they were supposed to be imagining helping). Incorrect trials were excluded from the analysis, and participants with >50% of trials incorrect were excluded from the study all together [19].

After data cleaning, 83 younger (*M* = 22.88, *SD* = 3.50, 63.9% women, 1.2% non-binary) and 91 older adults (*M* = 70.88, *SD* = 4.69, 53.8% women) with usable data remained for analysis. Among younger adults, 47% self-identified as White, Caucasian, or European, 13.3% as Asian, 18.1% as Black, African American/Canadian or African, 2.4% as Canadian (including French Canadian), 2.4% as mixed ethnicity, 2.4% as Middle Eastern, 6% as Hispanic or Latin American, 1.2% as Caribbean, 1.2% as Native American, and 6% as unknown or refused to answer. Among older adults, 75.8% self-identified as White, Caucasian, or European, 15.4% as Canadian or American, 3.3% as Asian, 2.2% as Black, African American/Canadian or African, 1.1% as Middle Eastern, 1.1% as Hispanic or Latin American, and 1.1% as Indian. To determine the observed power in our final, cleaned sample (n =174), we conducted a post-hoc power analysis using G*Power, where alpha = .05 and the correlation between repeated measures = 0.49 [32]. Results indicate that a power of .887 was achieved to detect the age x condition interaction. However, it is important to note that post-hoc power calculations that derive effect sizes from the collected data can be misleading [33].

Participants from the pilot and experimental studies gave informed consent to participate and were free to exit the studies at any time. The present research was approved by the Research Ethics Board of Brock University (21-034), and all research was conducted in accordance with the approved guidelines/regulations.

Experimental Procedure

The present study adapted the paradigm used in previous research on episodic simulation of helping behaviour [17-19, 28]. Participants read one-line stories depicting examples of people in need of help. Half of the stories described events that were similar to those previously experienced by younger adults (e.g., "After a day out with friends, this person sees I tagged in an unflattering photo online."), while the other half were similar to those previously experienced by older adults (e.g., "This person has found out they have not saved enough for their retirement."). In separate blocks, participants were asked to either: 1) focus on the story by considering its journalistic style and online media source (No Helping condition) or 2) imagine a vivid scenario of helping the person in need (Imagine Helping condition). Block order and stories were counterbalanced across participants.

At the beginning of each block participants completed a practice trial and were asked whether they understood the instructions. Anyone who indicated they did not understand the instructions were provided with further instructions/examples, and those who reported understanding the task were immediately forwarded to the experiment. Anyone who did not understand the instructions after two checks was screened out of the study.

On each trial, the story was displayed in the centre of the screen for 10 seconds followed by the condition prompt. During the condition prompt, participants provided a written description of their imagined scenario or how they judged the style of the story. Each prompt lasted a minimum of 60 seconds, but participants were able to continue writing if they wanted more time. Participants then completed self-paced ratings of how willing they would be to help the person in need (1 = not at all – 7 = very willing), scene coherence (1 = vague – 7 = coherent and clear) and detail (1 = simple – 7 = detailed) in their mind, whether the story made them feel troubled, distressed, sympathetic, compassionate, worried, and moved (1 = not at all – 7 extremely for each emotion separately), and how much they considered the thoughts and feelings of the person in need (i.e., perspective-taking; 1 = not at all – 7 = a great deal). Participants also rated each scenario on how similar it was to situations they have previously experienced (1 = not at all – 7 = very similar). Participants completed 12 trials in total, with 3 younger-familiar and 3 older-familiar scenarios stories in each condition (Imagine Helping vs No Helping). Because the vividness of imagined future events can be influenced by individual differences in visual imagery capacity [21], participants completed the Vividness of Visual Imagery Questionnaire (VVIQ) [35]. There was no significant difference between younger (M = 76.63, SE = 2.66) and older (M = 69.84, SE = 2.61) adults' scores on the VVIQ, t (172) = 1.82, p = .071, suggesting that self-reported mental imagery ability was similar between groups. Finally, participants completed a version of the Mini-Mental State Examination (MMSE) [37] that has been adapted for remote administration [34], and a demographics questionnaire.

Analytic Plan

The present study builds on previous work by using hierarchical mixed effect modeling to conduct trial-wise, rather than participant-wise analyses (i.e., an ANOVA for primary [17, 18, 28] or exploratory analyses [18, 19]). This also allowed us to use participants' actual ratings of situation similarity on a situation-by-situation basis, rather than dichotomizing the variable [18, 28], which allows us to take individual experience into account.

We used the lmer package in R to construct hierarchical mixed effects models. To account for individual differences, we included participant id as a random effect in the model. Further, because the stimuli in the current study may differ in other ways apart from similarity to one's previous experiences (e.g., social vs non-social tasks), we also included story as a random effect when constructing the initial model. Random effects and fixed factors were added to the model one at a time in the following order: 1) Condition, 2) Similarity Ratings, 3) Condition x Similarity Ratings, 4) Age, 5) Condition x Age, 6) Similarity Ratings x Age, and 7) Age x Condition x Similarity Ratings. These 7 models were compared, and the best fit model was constructed by including only predictors that improved model fit [38]. Follow-up t-tests and mixed effects models were conducted to explore the nature of interactions when appropriate. To examine potential mechanisms of episodic simulation in younger and older adults, moderated mediation analyses were conducted using the "MLMED" macro [39]. Specifically, on episodic simulation trials only, we tested whether the relationship between similarity and willingness to help was moderated by different phenomenological experiences (i.e., scene vividness, emotional concern, and perspective-taking) in each age group. Participants' willingness to help ratings were entered as the dependent variable, situation similarity ratings the independent variable, phenomenological experiences as potential mediators, and age group as a potential moderator. Follow-up mediation analyses within each age group were then performed for any effects that were significantly moderated by age.

Results

Situation Similarity Ratings

As a manipulation check, we first conducted a 2 (Story Type: Younger Familiar vs. Older Familiar) X 2 (Age: Younger vs. Older Adults) repeated measures ANOVA on participants' ratings of situation similarity. There was a main effect of story, F (1, 172) = 34.56, $p < .001$, $\eta p^2 = 0.167$, due to participants rating older-familiar (M = 3.61, SE = .11) stories as being more similar to situations they had previously experienced than the younger-familiar stories (M = 3.12, SE = .11) overall. There was also a main effect of age, F (1, 172) = 6.78, p = .010, $\eta p^2 = 0.038$, due to younger adults (*M* = 3.63, *SE* = .15) rating all scenarios as more similar to those they had previously experienced than older adults (*M* = 3.09, *SE* = .14). Finally, we found a significant story type by age interaction, F (1, 172) = 66.45, $p < .001$, $\eta p^2 = 0.279$. Pairwise t-tests confirmed that older adults rated older-familiar (*M* = 3.68, *SE* = .15) stories as being more similar to those they had previously experienced than younger-familiar stories (*M* = 2.51, *SE* = .14), t (90) = 9.58, $p < .001$, and younger adults rated younger-familiar stories (*M* = 3.73, *SE* = .17) as being more similar to those they had previously experienced than older-familiar stories (*M* = 3.54, *SE* = .17), t (82) = 1.69, $p = .047$. Thus, both groups rated their own-group stories as being more similar to their previous experiences than other-group stories. It should be noted that while we performed a manipulation check by treating story similarity as a categorical variable with two levels (i.e., old-familiar, young-familiar), the following analyses use participants' individual ratings of situation similarity as these are more specific to each individual's previous experiences and can take cross-trial variability into account.

Effects of Condition and Story Similarity

Willingness to help. The model predicting willingness to help included participant id (ICC = 0.46) and story number, $\chi 2(1) = 69.59$, $p < .001$; ICC = 0.50, as random effects. Condition, $\chi 2(1) = 143.13$, $p < .001$, and similarity, $\chi 2(1) = 124.02$, $p < .001$, were found to improve model fit and were retained for the best fit model. All other predictors did not improve model fit, *p's* > .118. The best fit model for willingness to help revealed an effect of condition, with participants reporting a greater willingness to help following episodic simulation (*M* = 5.06, *SE* = .13) compared to the control condition (*M* = 4.34, *SE* = .14; see Figure 1A for observed means and Table 2 for best fit estimates). The best fit model also revealed a positive effect of similarity, such that higher levels of situation similarity were related to a greater willingness to help overall (see Figure 1B).

Table 3.2

Best fit models

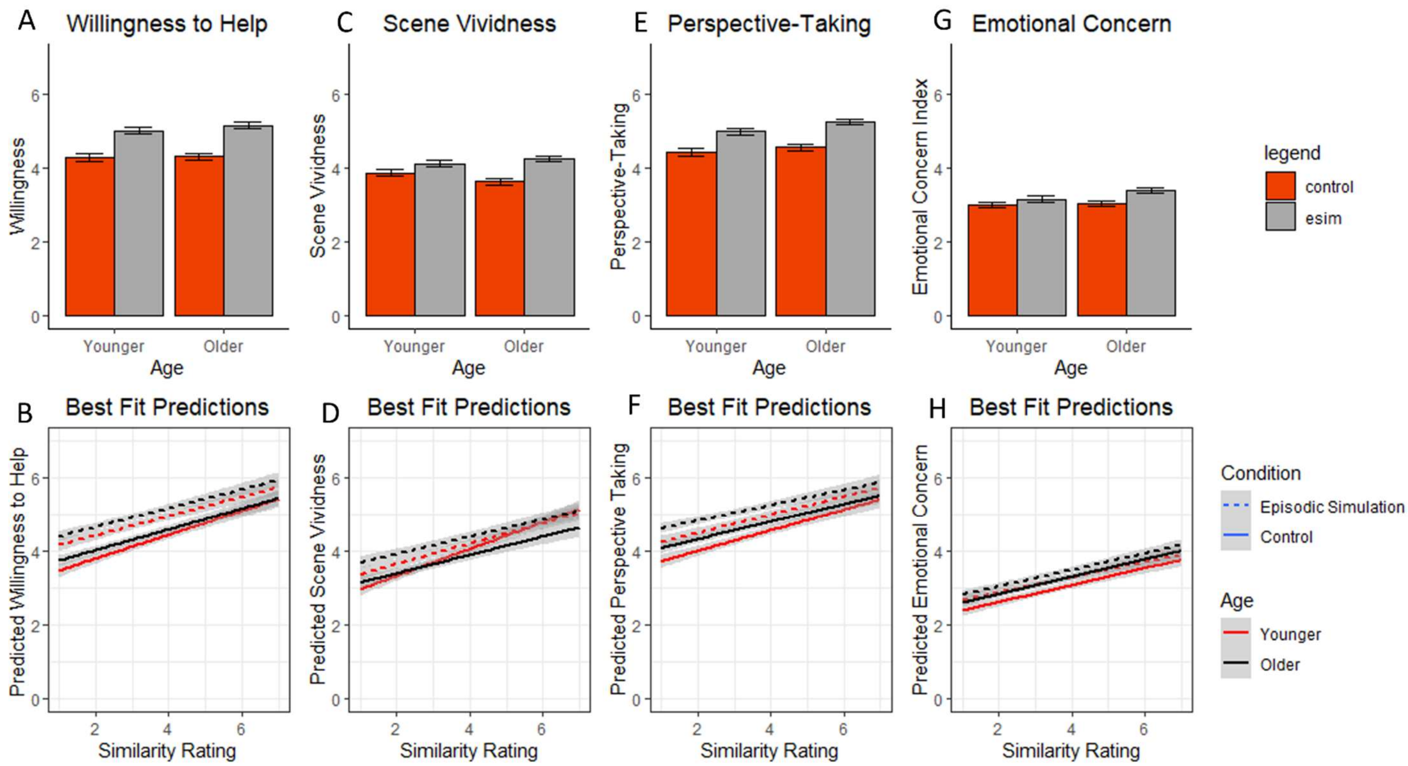
	Willingness			Scene Vividness			Emotional Concern			Perspective-taking		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	3.71	3.42 – 3.99	**<0.001**	3.20	2.83 – 3.56	**<0.001**	2.63	2.37 – 2.89	**<0.001**	4.04	3.78 – 4.29	**<0.001**
Condition	0.73	0.60 – 0.85	**<0.001**	0.20	0.05 – 0.35	**0.011**	0.23	0.13 – 0.34	**<0.001**	0.57	0.45 – 0.69	**<0.001**
Similarity	0.19	0.16 – 0.23	**<0.001**	0.21	0.17 – 0.25	**<0.001**	0.12	0.09 – 0.15	**<0.001**	0.15	0.12 – 0.18	**<0.001**
Control Trials: Age Contrast				0.23	-0.24 – 0.70	0.341						
Simulated Trials: Age Contrast				0.53	0.06 – 1.00	**0.029**						
Similarity: Age Contrast				-0.11	-0.16 – -0.05	**<0.001**						
Random Effects												
σ^2	1.71			1.16			1.30			1.60		
τ_{00}	1.53 $_{\text{Participant ID}}$			1.87 $_{\text{Participant ID}}$			1.07 $_{\text{Participant ID}}$			1.56 $_{\text{Participant ID}}$		

	0.09 Story #	0.03 Story #	0.09 Story #	0.04 Story #
ICC	0.49	0.62	0.47	0.50
N	172 Participant ID	172 Participant ID	172 Participant ID	172 Participant ID
	12 Story #	12 Story #	12 Story #	12 Story #
Observations	1854	1854	1854	1854
Marginal R^2 / Conditional R^2	0.092 / 0.533	0.051 / 0.641	0.037 / 0.491	0.062 / 0.532

Note: Contrasts reflect the comparison to the control condition and younger adults.

Figure 3.1.

Observed means of participants' ratings and best fit model predictions across conditions.



Note: Error bars and shaded portions represent standard error of the mean.

Scene vividness. Scene vividness was calculated by averaging participants' ratings of coherence and detail on each trial [23]. In terms of predicting scene vividness ratings, both participant id (ICC = 0.62) and story number, $\chi2(1) = 17.21$, $p < .001$; ICC = 0.63 were retained as random factors. Condition, $\chi2(1) = 50.30$, $p < .001$, similarity, $\chi2(1) = 104.06$, $p < .001$, the condition by age interaction, $\chi2(1) = 6.90$, $p = .008$, and the similarity by age interaction, $\chi2(1) = 14.725$, $p < .001$ were found to improve model fit and were retained for the best fit model. All other predictors did not improve model fit, *p's* > .307.

The best fit model for scene vividness revealed an effect of condition, with participants reporting higher scene vividness ratings following episodic simulation ($M = 4.17$, $SE = 0.12$)

compared to the control condition (*M* = 3.82, *SE* = 0.12; see Figure 1C for observed means and Table 2 for best fit estimates). There was also an effect of similarity, such that higher similarity ratings were related to increased scene vividness ratings (see Figure 1D). The similarity by age interaction was due to the relationship between similarity and scene vividness being attenuated in older adults (see below). The condition by age interaction was due to an age effect in the imagined, but not control condition. A follow-up analysis revealed that although the effect of condition increased scene vividness ratings for both younger, $t(1680) = 2.55$ $p = .011$, and older adults, $t(1675) = 7.25$ $p < .001$, the change was more pronounced in older adults.

To further explore the interaction between similarity and age on scene vividness, we constructed best fit models separately within each age group. In younger adults, both participant id (ICC = 0.53) and story number, $\chi2(1) = 6.61$, $p = .01$; ICC = 0.55 were retained as random factors. Condition, $\chi2(1) = 6.76$, $p = .009$ and similarity, $\chi2(1) = 80.48$, $p < .001$, were found to improve model fit and were retained for the best fit model. The condition by similarity interaction did not improve model fit, $p = .491$.

The best fit model for scene vividness ratings in younger adults confirmed there was an effect of condition, *B* = 0.19, *SE* = 0.08, $t(740.92) = 2.30$, 95% *CI* [0.03, 0.36], with younger participants reporting greater scene vividness following episodic simulation (*M* = 4.13, *SE* = .16) compared to the control condition (*M* = 3.94, *SE* = .17). There was also a positive effect of similarity, *B* = 0.22, *SE* = 0.02, $t(804.22) = 9.22$, 95% *CI* [0.17, 0.27], such that higher levels of situation similarity ratings were related to greater scene vividness. Random effects for the best fit model were $\sigma^2 = 1.40$, ICC = 0.52, $\tau_{00\ id} = 1.47$, $\tau_{00\ Story\ Number} = 0.06$. Marginal and Conditional R^2 for the model were 0.076 and 0.559, respectively.

In older adults, both participant id (ICC = 0.69) and story number, $\chi 2(1) = 6.61$, $p = .01$; ICC = 0.70 were retained as random factors. Condition, $\chi 2(1) = 68.10$, $p < .001$ and similarity, $\chi 2(1) = 27.85$, $p < .001$, were found to improve model fit and were retained for the best fit model. The condition by similarity interaction did not improve model fit, $p = .450$.

The best fit model for scene vividness ratings in older adults confirmed there was an effect of condition, $B = 0.49$, $SE = 0.06$, $t(930) = 7.94$, 95% CI [0.37, 0.61], with older participants reporting greater scene vividness following episodic simulation ($M = 4.23$, $SE = .17$) compared to the control condition ($M = 3.74$, $SE = .17$). There was also a positive effect of similarity $B = 0.09$, $SE = 0.02$, $t(682) = 5.33$, 95% CI [0.06, 0.12], such that higher levels of situation similarity ratings were related to greater scene vividness. Random effects for the best fit model were $\sigma^2 = .95$, ICC = 0.70, $\tau_{00\ \text{id}} = 2.23$, $\tau_{00\ \text{Story Number}} = 0.01$. Marginal and Conditional R^2 for the model were 0.033 and 0.711, respectively. Thus, the interaction between similarity and age on scene vividness in the combined model is due to the effect of similarity being significantly attenuated in the older group.

Perspective-taking. In terms of predicting perspective-taking, both participant id (ICC = 0.49) and story number, $\chi 2(1) = 32.42$, $p < .001$; ICC = 0.51 were retained as random factors. Condition, $\chi 2(1) = 98.48$, $p < .001$, similarity, $\chi 2(1) = 84.59$, $p < .001$, and the condition by similarity interaction, $\chi 2(1) = 4.10$, $p = .042$ were found to improve model fit and were retained for the best fit model. All other predictors did not improve model fit, *p's* > .133.

The best fit model for perspective-taking revealed an effect of condition, with participants reporting greater consideration of the thoughts and feelings of the individual (i.e., perspective-taking) following episodic simulation ($M = 5.11$, $SE = .12$) compared to the control condition ($M = 4.54$, $SE = .12$; see Figure 1E for observed means). The best fit model also revealed a positive effect of similarity, such that higher levels of situation similarity ratings related to greater perspective-taking (see Figure 1F). However, the interaction between similarity and condition revealed that the relationship between similarity and perspective-taking was significantly attenuated in the imagined condition, $B = -0.06$, $SE = 0.03$, $t(1700.60) = 2.03$, 95% *CI* [-0.11, -0.00].

Emotional concern. In keeping with previous research, emotional concern was calculated by averaging participants' ratings of emotions felt on each trial [19, 23] (see SI for a similar pattern of results using empathic concern). In terms of predicting emotional concern ratings, both participant id (ICC = 0.45) and story number, $\chi 2(1) = 94.38$, $p < .001$; ICC = 0.49 were retained as random factors. Condition, $\chi 2(1) = 23.53$, $p < .001$ and similarity, $\chi 2(1) = 68.33$, $p < .001$, were found to improve model fit and were retained for the best fit model. All other predictors did not improve model fit, *p's* > .093.

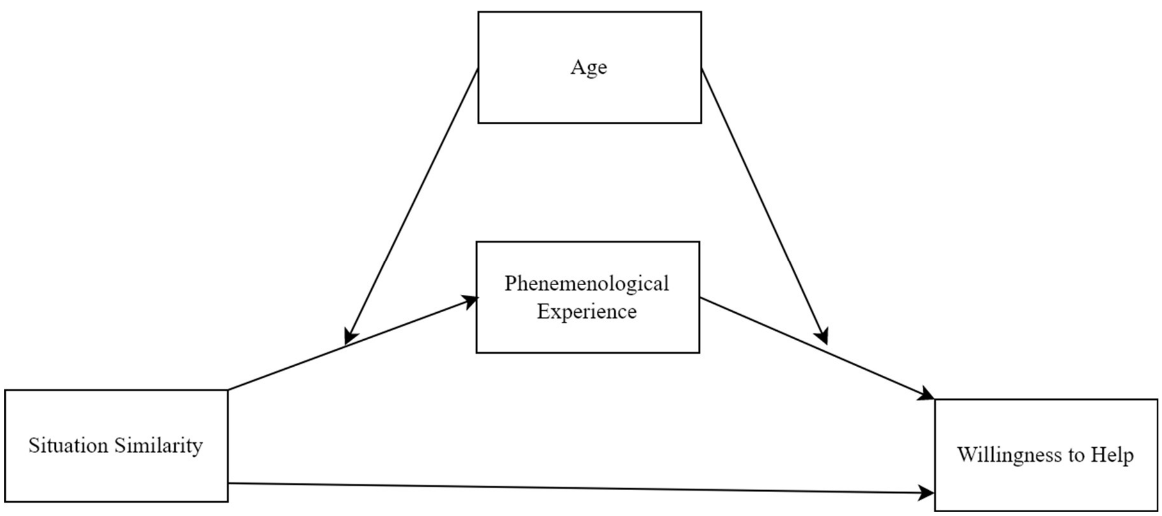
The best fit model for emotional concern revealed an effect of condition, with participants reporting greater emotional concern for the person in need following episodic simulation ($M = 3.27$, $SE = .13$) compared to the control condition ($M = 3.03$, $SE = .12$; see Figure 1G for observed means). The best fit model also revealed a positive effect of similarity, such that higher levels of situation similarity ratings were related to greater emotional concern (see Figure 1H).

Modeling the Effect of Similarity on Willingness to Help Through Phenomenological Experience

To further examine how one's previous experiences influence willingness to help in younger and older adults following episodic simulation, we conducted a series of moderated mediation analyses on simulated trials in which willingness to help was the dependent variable, situation similarity the independent variable, phenomenological experiences the potential mediators (one at a time), and age group a potential moderator (see Figure 2 for a conceptual diagram). Because episodic memory can influence cognitive and affective empathy [35] we also tested whether the relationship between episodic simulation and willingness to help was mediated by perspective taking (i.e., cognitive empathy) and/or emotional concern (i.e., affective empathy) while controlling for scene vividness (see Supplementary Information).

Figure 3.2.

Conceptual diagram of the indirect effect of situation similarity on willingness to help, moderated by age.



Note: Phenomenological experience refers to scene vividness, perspective-taking, and emotional concern. Each phenomenological experience was initially explored as a potential mediator in separate models. Significant mediators were then tested in parallel.

For scene vividness, we found an indirect effect of situation similarity on willingness to help via scene vividness, effect = .06, SE = .01, 95% *CI* (.04, .09), suggesting that situation similarity influences scene vividness, which in turn influences participants' willingness to help. As expected, we also found a significant interaction between age and similarity on scene vividness, effect = -.10, SE = .04, 95% *CI* (-.18, -.03), suggesting that the path between similarity and scene vividness differs between younger and older adults. This was confirmed by the index of moderated mediation, estimate = -.03, 95% *CI* (-.07, -.01). There was no interaction between age and scene vividness on willingness to help, effect = -.04, SE = .08, 95% *CI* (-.20, .11), suggesting that the path between scene vividness and willingness to help did not differ across age groups. This was confirmed by the index of moderated mediation, estimate = -.01, 95% *CI* (-.04, .03). Follow-up mediation analyses within each age group revealed that there was a stronger indirect effect of scene vividness in younger adults, effect = .07, SE = .02, 95% *CI* (.04, .10) than in older adults, effect = .02, SE = .01, 95% *CI* (.01, .04).

For emotional concern, we found an indirect effect of situation similarity on willingness to help via emotional concern, effect = .04, SE = .01, 95% *CI* (.01, .07), suggesting that greater familiarity with a situation increases emotional concern, which in turn influences willingness to help. The indices of moderated mediation were not significant for the path between similarity and emotional concern, estimate = -.02, 95% *CI* (-.05, .02), nor emotional concern and willingness to help, estimate = -.002, 95% *CI* (-.02, .01), suggesting that the indirect effect was of similar magnitude in both younger and older adults (notably, these results do not change when using empathic concern as discussed in the SI).

For perspective-taking, we found an indirect effect of situation similarity on willingness to help via perspective-taking, effect = .05, SE = .02, 95% *CI* (.01, .09), suggesting that greater familiarity with a situation relates to greater consideration of the thoughts and feelings of the person in need, which in turn influences willingness to help. The index of moderated mediation for the path from similarity to perspective taking was not significant, estimate = .02, 95% *CI* (-.04, .07). However, there was a significant interaction between age and perspective taking on willingness to help, effect = .13, SE = .06, 95% *CI* (.02, .24), suggesting that the path between perspective taking and willingness to help differs between younger and older adults. This was confirmed by the index of moderated mediation, estimate = .01, 95% *CI* (.0005, .02). Follow-up mediation analyses within each age group revealed that there was a stronger indirect effect of perspective taking in older adults, effect = .08, SE = .02, 95% *CI* (.04, .11) than in younger adults, effect = .05, SE = .02, 95% *CI* (.01, .09).

Since all three phenomenological experiences showed similar mediating effects, we finally ran parallel mediation models in younger and older adults separately with scene vividness, emotional concern, and perspective-taking entered into each model together. In younger adults, the paths through scene vividness, effect = .03, SE = .01, 95% *CI* (.01, .05), and perspective-taking, effect = .04, SE = .02, 95% *CI* (.01, .08), were both significant. The indirect path through emotional concern was not significant, effect = .01, SE = .01, 95% *CI* (-.01, .02). In older adults, the path through perspective-taking, effect = .07, SE = .02, 95% *CI* (.04, .11) was significant. However, the indirect effects of scene vividness, effect = .01, SE = .004, 95% *CI* (-.002, .01) and emotional concern, effect = .002, SE = .003, 95% *CI* (-.002, .11) were not significant. Taken together, these findings suggest that following episodic simulation, one's previous experience influence willingness to help via different mechanisms in younger and older adults.

Discussion

The present study explored how situation similarity influences episodic simulation of helping behaviour in younger and older adults. We demonstrate that story similarity ratings (i.e., how similar a situation is to those previously experienced) influences one's willingness to help overall, with people being more willing to help in situations that are similar to those they have personally experienced. Further, episodic simulation brought about cognitive change by increasing willingness to help, scene vividness, emotional and empathic (see SI) concern, and perspective-taking relative to a baseline condition. Notably, the lack of age difference in these effects suggests that older adults can engage in episodic simulation to a similar degree as younger adults. However, exploration of previously identified mechanisms through which episodic simulation affects prosocial intentions [18, 28] revealed that these mechanisms seem to differ between younger and older adults. In the present study, story similarity was found to act via different mechanisms in younger and older adults, with younger adults showing indirect effects through scene vividness and perspective-taking, while older adults showed an indirect effect through perspective-taking only. Strikingly, the indirect paths seemed to be influenced by age at different stages. Specifically, advanced age had a negative effect on the relationship between situation similarity and scene imagery, but a positive effect on the relationship between perspective taking and willingness to help. Notably, in parallel mediation models, both younger and older adults did not show an indirect effect of emotional concern. Taken together, these findings suggest that episodic simulation is relatively preserved with age, and that personal experience with similar situations influences simulated outcomes, such as willingness to help, via different mechanisms in younger and older adults.

Previous work exploring how one's lived experiences affect episodic simulation has typically contrasted common, everyday scenarios with largely hypothetical events (e.g., climbing Mount Everest) [24-25, 30] or manipulated familiarity of the imagined location itself [28, 28]. Critically, the work here uses a series of stimuli that were created in consultation with older adults, and piloted on an initial sample, to help ensure suitable variability in how similar stories were to older adults' previous experiences (i.e., ensuring half the stories were similar and half were dissimilar to the typical experiences of older adults). Further, the analytical approach used in the current study also takes into account participants' individual ratings of situation similarity (treating similarity as a continuous, rather than as a discrete, measure). By using real-world scenarios that are familiar to either older or younger adults and taking a trial-by-trial approach to the data, the current study contributes to the literature by showing how one's previous experience influences episodic simulation of helping behaviour in older adults.

Although episodic simulation may similarly increase willingness to help in both older and younger adults, recent work suggests that baseline levels of prosociality, and concern for the 'greater good', may be higher in older adults [18, 28]. Indeed, compared to younger adults, older adults show less of a self-serving bias, in that they expend a similar amount of effort to help others as they do to benefit themselves [41]. Moreover, although some research indicates that older adults exhibit reduced cognitive empathy (i.e., perspective taking of others' emotional state [42, 43], affective empathy (i.e., feeling, compassion) is relatively stable across the lifespan [44]. Such findings are in line with the *socioemotional selectivity theory*, which suggests that older adults are motivated to partake in activities that maximize emotional fulfillment and focus on the common good [40, 45-47]. As such, despite the evidence for age-related decline in episodic memory and simulation, chronic goal shifts toward emotional well-being and the greater good may motivate older adults to try harder when imagining themselves helping those in need, or consider themselves as being more willing to help regardless of their simulation abilities.

Limitations & Future Directions

Future research should aim to address some of the limitations of the present study. First, the current study was conducted online. While many in-lab cognitive experiments have been replicated online (including the current paradigm [19, 28]), older adults who participate in online studies may be higher functioning or more computer literate than those typically tested in the lab [48]. Relatedly, the age range of older adults in the present study (60-80 years old) may include individuals who are not yet experiencing age-related cognitive decline. Thus, the current sample may consist of older adults who are not experiencing the same level of cognitive decline as those typically tested in-lab. Second, the current sample of participants consists of Canadian residents and may represent a Western, Industrialized, Educated, Rich, Democratic (WEIRD) sample [49]. Because the positivity effect may differ across cultures [50], future research should aim to replicate the present findings in a different culture. Finally, the current findings on the mechanistic differences of episodic simulation in younger and older adults should be explored using paradigms that do not necessarily hinge on simulating helping behaviours. As discussed, older adults' tendency to prioritize the greater good may affect their willingness to help in addition to any simulation effects, clouding potential age-related differences.

In conclusion, the present study demonstrates an important role for one's previous experience when simulating future events. Specifically, situation similarity made significant contributions to individuals' willingness to help, scene vividness, emotional concern, and perspective-taking. Perhaps the most striking finding here is that situation similarity affected willingness to help via different mechanisms in older and younger adults. On trials where participants imagined future helping events, older adults engaged in more perspective-taking when the helping scenarios were more similar to those they had personally experienced, and this increased their willingness to help; in contrast, younger adults were additionally better at picturing the scene and this increased their willingness to help. While episodic memory and perspective-taking share overlap [35], it is possible to have perspective-taking without episodic memory [51]. Thus, it is conceivable that if episodic memory is inaccessible or impoverished, as it is thought to be in older adults, one's previous experience influences future simulations via different mechanisms, especially when such events are in line with age-related shifts in chronic prosocial goals.

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Supplementary Information

Materials

Scenario List

Younger-Familiar

- While at a party, this person suspects that their drink has been spiked.
- This person needs to select a form of birth control.
- After a day out with friends, this person sees themself tagged in an unflattering photo online.
- After making a new profile, this person has not gotten any matches on their favourite dating app.
- This person has been locked out of their email account.
- This person is being publicly ridiculed online.

Older-Familiar

- This person needs to use a paper map to navigate a rural town.
- This person needs to write a cheque for a friend but does not know how.
- This person has found out they have not saved enough for their retirement.
- This person needs to schedule an appointment with a new specialist.
- After the death of a family member, this person needs to plan a funeral.
- This person needs to buy home insurance and is unsure of who to contact.

Results

Empathic concern. Because research examining younger and older adults' episodic simulation of helping behaviour has also examined empathic concern [18], we created a composite variable by averaging *only* participants' ratings of sympathy, compassion, and the extent to which they were moved by the stories. In terms of predicting empathic concern, both participant id (ICC = 0.47) and story number (ICC = 0.50) , $\chi 2(1) = 94.38$, $p < .001$, were retained as random factors. Condition, $\chi 2(1) = 51.88$, $p < .001$, similarity, $\chi 2(1) = 102.47$, $p < .001$, and age, $\chi 2(1) = 7.08$, $p < .008$ were found to improve model fit and were retained for the best fit model. There was also a trend towards the interaction between age and condition, $\chi 2(1) = 3.86$, $p = .049$, that was retained for the best fit model for exploratory purposes. All other predictors did not improve model fit, *p's* > .167.

The best fit model for empathic concern (see Table S1) revealed an effect of condition, with participants reporting greater empathic concern for the person in need following episodic simulation (*M* = 3.94, *SE* = .13) compared to the control condition (*M* = 3.55, *SE* = .13). The best fit model also revealed a positive effect of similarity, such that higher levels of situation similarity ratings were related to greater empathic concern. Although older adults (*M* = 3.99, *SE* = .15) reported numerically higher empathic concern than younger adults (*M* = 3.49, *SE* = .16), the contrast failed to reach significance. Follow-up t-tests revealed that the interaction between age and condition was due to the effect of condition being larger in older (mean difference = 0.52, *SE* = .08, $t(1679) = 6.36$, $p<.001$) than younger adults (mean difference = 0.27, *SE* = .09, $t(1687) = 2.92$, $p = .004$). Thus, using empathic concern instead of emotional concern yielded a highly similar pattern of results.

Table 3.S1

Best fit models for emotional and empathic concern

	Emotional Concern			Empathic Concern		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	2.63	2.37 – 2.89	**<0.001**	2.79	2.44 – 3.14	**<0.001**
Condition	0.23	0.13 – 0.34	**<0.001**	0.27	0.09 – 0.44	**0.004**
Similarity	0.12	0.09 – 0.15	**<0.001**	0.17	0.14 – 0.20	**<0.001**
Effect of Age				0.38	-0.02 – 0.78	0.063
Effect of Condition Across Age Groups				0.25	0.01 – 0.49	**0.040**
Random Effects						
σ^2	1.30			1.63		
τ_{00}	1.07 Participant ID			1.44 Participant ID		
	0.09 Story Number			0.07 Story Number		
ICC	0.47			0.48		
N	172 Participant ID			172 Participant ID		
	12 Story Number			12 Story Number		
Observations	1854			1854		
Marginal R^2 / Conditional R^2	0.037 / 0.491			0.074 / 0.519		

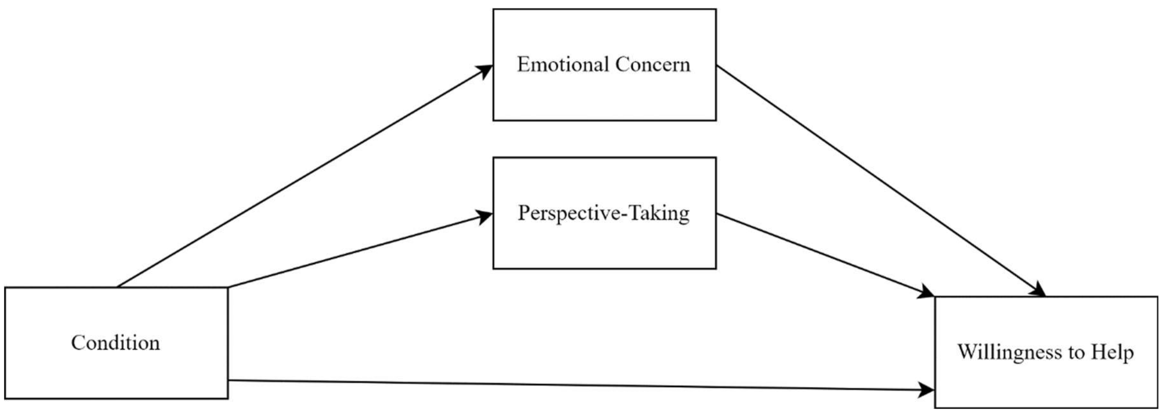
Note: Contrasts reflect the comparison to the control condition and younger adults.

Modeling the Effect of Episodic Simulation on Willingness to Help Through Emotional Concern and Perspective-Taking

To examine whether perspective taking or emotional concern have a greater impact on willingness to help following episodic simulation of helping behaviours, we conducted moderated mediation analyses using the “MLMED" macro. For these analyses, participants’ willingness to help ratings were entered as the dependent variable, condition (control vs episodic simulation) as the independent variable, perspective taking or emotional concern as a potential mediator, and age group as a potential moderator. Because scene vividness was found to be a major contributor to willingness to help in our current and prior work [19], scene vividness was entered into the model as a covariate. Moderation was tested on each potential mediator separately at first, and follow-up mediation analyses were then performed in parallel (see Figure S1 for a conceptual diagram).

Figure 3.S1.

Conceptual diagram of the indirect effect of condition on willingness to help, moderated by age.



Note: Each potential mediator was initially explored in separate models and subsequently tested in parallel.

For emotional concern, the indirect effect of condition on willingness to help was not significant, effect = .03, SE = .04, 95% *CI* (-.05, .10), suggesting that episodic simulation did not influence willingness to help by increasing participants' emotional concern for the person in need. The indices of moderated mediation were not significant for the path between condition and emotional concern, estimate = .05, 95% *CI* (-.04, .15), nor emotional concern and willingness to help, estimate = -.003, 95% *CI* (-.02, .01), suggesting that the non-significant indirect effect was of similar magnitude in both younger and older adults.

For perspective-taking, we found an indirect effect of condition on willingness to help via perspective-taking, effect = .30, SE = .06, 95% *CI* (.19, .41), suggesting that simulating future helping scenarios relates to greater consideration of the thoughts and feelings of the person in need, which in turn influences willingness to help. The index of moderated mediation for the path from condition to perspective taking was not significant, estimate = -.03, 95% *CI* (-.17, .12), nor perspective-taking to willingness to help, estimate = .03, 95% *CI* (-.004, .07), suggesting that the significant indirect effect was of similar magnitude in both younger and older adults.

For exploratory purposes, we finally ran a parallel mediation model with emotional concern, and perspective-taking entered into the model as mediators and scene vividness as a covariate. The path through perspective-taking, effect = .28, SE = .04, 95% *CI* (.21, .35) was found to be significant. The indirect path through emotional concern was trending, effect = .01, SE = .01, 95% *CI* (.001, .03), but failed to reach significance (p =.056). Finally, the contrast between indirect effects was significant, effect = -.26, 95% *CI* (-,34, -.19), confirming that the indirect path via perspective-taking was stronger than the indirect path via emotional concern.

Chapter 4: Time spent imagining does not influence younger and older adults' episodic simulation of helping behaviour

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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 imagining future scenarios. We examined whether imposing time limits on episodic simulation of future helping scenarios affects younger and older adults' willingness to help, phenomenological experience of the imagined event, and the type of details produced. We demonstrate that relative to a semantic control task, episodic simulation increases younger and older participants' willingness to help, vividness of the imagined scene, and perspective taking regardless of the time spent simulating future helping scenarios. In contrast, the number of internal details produced increased with time spent imagining. Moreover, time did not influence the proportion of internal details produced, suggesting that participants' verbosity remained consistent regardless of the time they spent imagining. Taken together, the present findings highlight the importance of collecting phenomenological experience when assessing episodic simulation abilities across the lifespan.

Keywords: episodic simulation, aging, scene vividness, perspective taking, helping behaviour

Episodic simulation refers to the generation of hypothetical scenarios that enable us to reconsider past events, plan for the future, and problem solve (Schacter & Addis, 2007). Simulating hypothetical future scenarios has been shown to shift our intentions and shape our future behaviours, such that imagining future events makes the hypothetical scenario feel more likely to occur and predicts whether participants will engage in the imagined behaviour in the future (Libby et al., 2007; Gregory et al.,1982). 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 et al., 2014; 2018).

Reconstructing past and simulating future events rely on similar neurocognitive processes. The *constructive episodic simulation hypothesis* posits that remembering the past 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, Wong, & Schacter, 2008). Addis et al. (2008) demonstrated strong correlations between the number of internal (episodic-like) details produced for remembered events and the number of internal details produced for imagined events. Moreover, the same was found for the number of external (semantic-like) details produced when individuals remember the past and imagine future scenarios, suggesting that similar processes may be responsible for the number of details produced (Addis et al., 2008). Notably, older adults were found to generate fewer internal details than younger adults both when remembering past and imagining future scenarios (Addis, Wong, & Schacter, 2008). Further, such findings have also been extended to 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; 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; Sawczak et al., 2019; Ryan et al., 2022). 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; Ryan et al., 2022). 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. 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. 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, Addis, Hodges, & Piguet, 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 to them; Ryan & Campbell, in press). Furthermore, episodic retrieval requires more effort and takes longer than (relatively automatic) semantic retrieval in both younger and older adults (Spaniol et al., 2006), with this timing difference even more pronounced in older adults (Spaniol et al., 2006). This increased demand of 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. 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.

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 a 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 varied the duration of the prompt screen (and thus, the time participants had to write their imagined scenarios) for 45, 60, or 75 seconds. 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 below) and their willingness to help the person in need. Previous work demonstrating that older adults produce fewer internal details than younger adults gave all participants the same limited amount of time to complete the task (Addis, Wong, & Schacter, 2008), and even when time spent imagining is limited to 60 seconds, these findings persist (Ryan et al., 2022 / Chapter 2). As such, in the present study, we were particularly interested in how further restricting time spent imagining would influence the type of details produced by older adults. 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.

Methods

Participants

Based on previous research that has tested this paradigm in online samples (Gaesser et al., 2018; Ryan et al., 2022), we aimed to test 100 younger (18-35 years) and 100 older adults (60-80 years). 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.

Procedure

The paradigm used in this study was adapted from previous research on episodic simulation of helping behaviour (Gaesser & Schacter 2014; Ryan et al., 2022). 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. These times were selected to allow participants sufficient time to type a brief description of their imagined scenarios, but not so long that online participants would disengage with the task. 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), scene 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), the similarity to situations they had previously experienced (1= not at all – 7 = very similar), 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.

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 et al., 2022), 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 above); 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, Svoboda, Hay, Winocur, & Moscovitch, 2002). In line with previous research (Gaesser et al., 2018, Ryan et al., 2022), 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, Dodds & Schacter, 2017).

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 x Age, 4) Time Spent on Condition,

5) Condition x Time Spent on Condition, 6) Age x Time Spent on Condition, 7) Condition x Age X 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 were added to the model one at a time: 1) Age, 2) Time Spent on Condition, 3) Age x 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 modelling was conducted to explore the nature of interactions when appropriate.

Results

Effects of Condition and Time Manipulation on Participant Ratings

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.

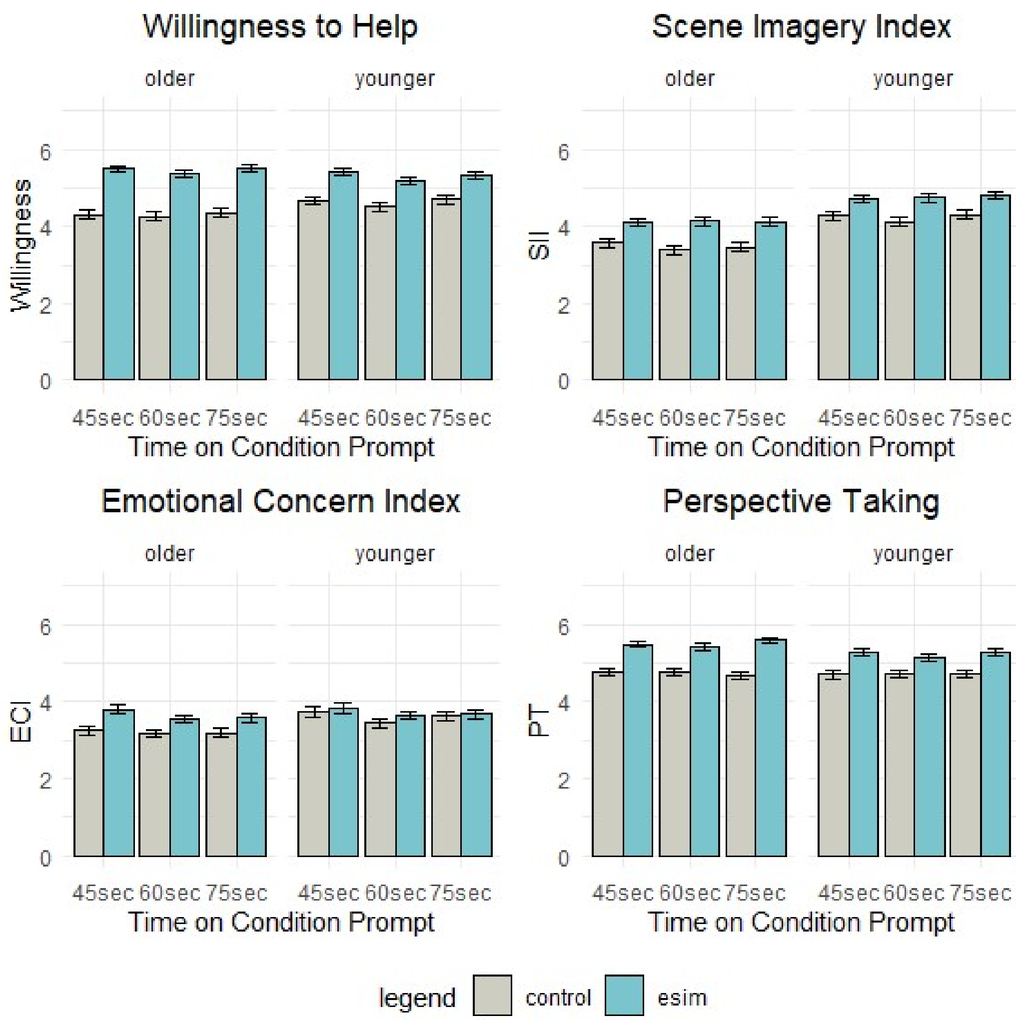
The best fit model for willingness to help revealed an effect of condition, $B = 0.63$, $SE = 0.06$, $t(3316.45) = 9.83$, 95% *CI* [0.50, 0.75], with participants reporting a greater willingness to help following episodic simulation ($M = 5.37$, $SE = .13$) compared to the control condition ($M = 4.48$, $SE = .13$; 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 σ^2 = 1.60, ICC = 0.45, $\tau_{00\ \text{id}}$ = 1.12, $\tau_{00\ \text{Story Number}}$ = 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), $\chi 2(1)$ = 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 σ^2 = 1.58, ICC = 0.42, $\tau_{00\ \text{id}}$ = .97, $\tau_{00\ \text{Story Number}}$ = 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), $\chi 2(1)$ = 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, *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 σ^2 = 1.61, ICC = 0.48, $\tau_{00\ \text{id}}$ = 1.26, $\tau_{00\ \text{Story Number}}$ = 0.24. Marginal and Conditional R^2 for the model were 0.097 and 0.533, respectively.

Figure 4.1.

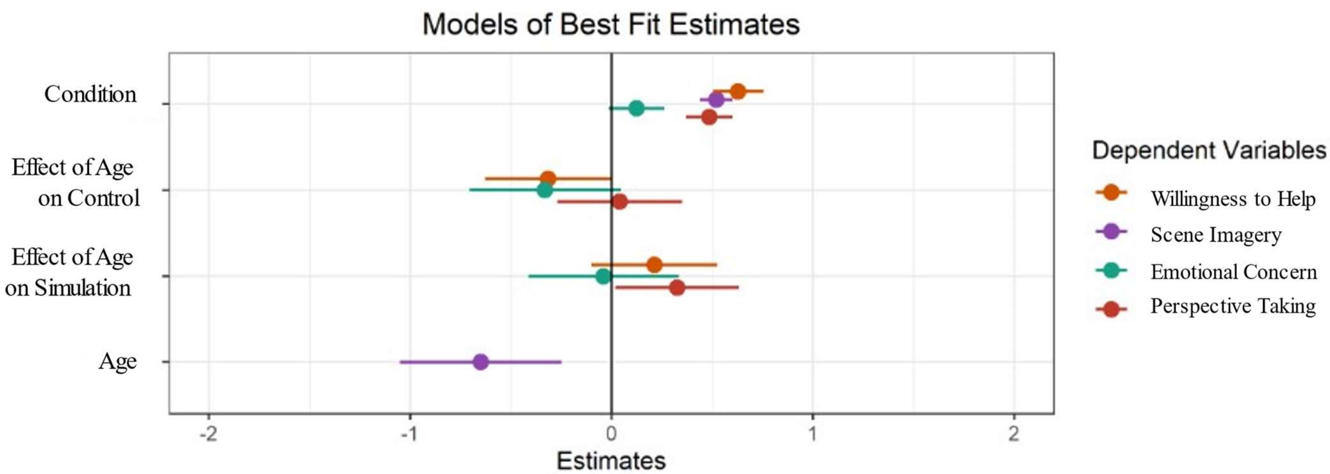
Observed means of participants' ratings across condition and time spent in condition.



Note: Error bars represent standard error of the mean. The age split is presented for the purpose of comparison with the other variables.

Figure 4.2.

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.

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,

$\tau_{00\ \mathrm{id}} = 2.08$, $\tau_{00\ \mathrm{Story\ Number}} = 0.03$. Marginal and Conditional R^2 for the model were 0.046 and 0.612, respectively.

Emotional Concern. The model predicting emotional concern included participant id (ICC = 0.42) and story number (ICC = 0.51), $\chi 2(1) = 473.86$, $p < .001$, as random effects. Condition, $\chi 2(1) = 35.70$, $p < .001$, and the condition by age interaction, $\chi 2(1) = 9.47$, $p = .001$, 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, $\tau_{00\ \mathrm{id}} = 1.65$, $\tau_{00\ \mathrm{Story\ Number}} = 0.33$. 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), $\chi 2(1) = 162.49$, $p < .001$, 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, $\tau_{00\ \mathrm{id}} = 1.50$, $\tau_{00\ \mathrm{Story\ Number}} = 0.28$. 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), $\chi 2(1) = 294.58$, $p < .001$, 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, $\tau_{00\ \mathrm{id}} = 1.79$, $\tau_{00\ \mathrm{Story\ Number}} = 0.40$. 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.

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, $\tau_{00\ \mathrm{id}} = 1.07$, $\tau_{00\ \mathrm{Story\ Number}} = 0.17$. 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, $\tau_{00\ \mathrm{id}} = 1.15$, $\tau_{00\ \mathrm{Story\ Number}} = 0.19$. 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.

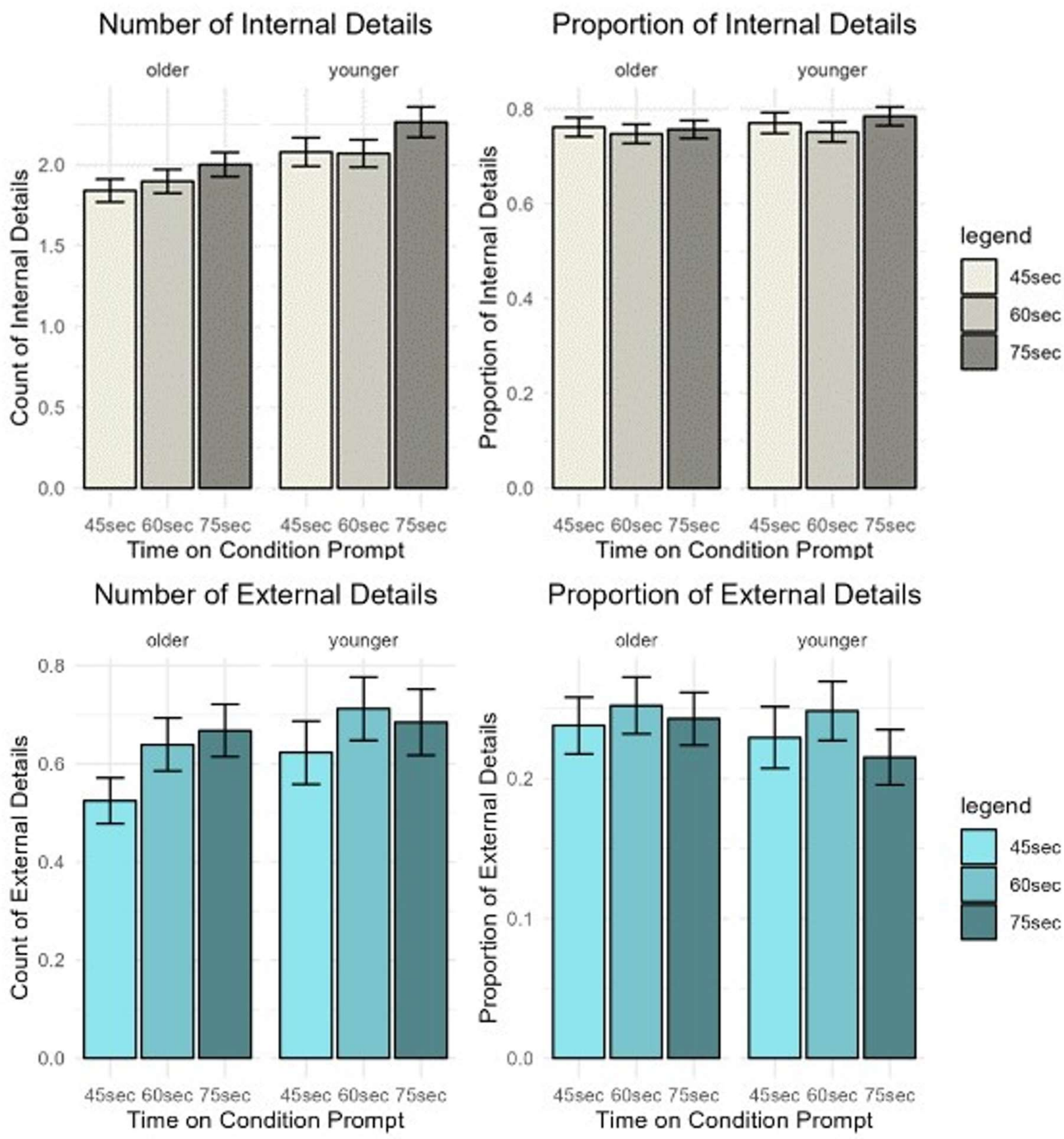
Effects of Time Manipulation on Internal Details Produced

Count of details. 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), $\chi 2(1) = 85.91$, $p < .001$, as random effects. The time spent imagining was found to add to the model and thus retained for the best fit model, $\chi 2(1) = 23.23$, $p < .001$. While younger adults produced numerically more internal details, neither age nor the other predictors improved model fit, *p's* > .212.

Figure 4.3.

Internal and external details produced on episodic simulation trials as average count and proportion.



Note: 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 towards 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), $\chi 2(1) = 29.60$, $p < .001$, as random effects. No fixed predictors improved model fit, *p's* > .161.

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 (Lockrow et al., 2023). The model predicting the proportion of internal details produced included participant id (ICC = 0.36) and story number (ICC = 0.39), $\chi 2(1) = 41.19$, $p < .001$, as random effects. None of the fixed factors improved model fit, *p*s > .290. In terms of the proportion of external details, the initial model included participant id (ICC = 0.36) and story number, $\chi 2(1) = 41.19$, $p < .001$; ICC = 0.39, as random effects. No fixed predictors improved model fit, *p*s > .290.

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.

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 et al., 2023) or limited all participants the same amount of time (Ryan et al., 2022, Addis, Wong, & Schacter, 2008). 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 et al., 2022). 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. 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. 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 imagining helping a person in need. Indeed, research suggests that older adults selectively engage with tasks that they consider to be meaningful (Hess 2014; Hess & Ennis 2012). As such, it is possible that framing future scenarios as an event that participants are involved with, in a domain that older adults care about, encourages engagement with the task and therefore, increases older participants' use of episodic details. Future research should aim to clarify the importance of these factors.

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, Lace & Eisenstein, 2020). 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. Indeed, age-related difference may emerge when time spent imagining is further restricted (i.e., only allowing participants to imagine future scenarios for 15 seconds). To test this possibility, future research should ask participants to verbalize their imagined scenarios as that would allow for more brief simulation durations to be tested. 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.

In conclusion, the present study suggests that time spent engaging in episodic simulation of helping 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 a proportional measure may be more appropriate to control for effects of verbosity (Lockrow et al., 2023) and/or age differences in the time spent talking/typing(Trunk & Abrams, 2009). 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.

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Chapter 5: General Discussion

The overarching goal of the present thesis was to examine factors that influence younger and older adults' episodic simulation of helping behaviours and in doing so, to identify how episodic simulation may differ across the lifespan. To this end, I conducted a series of within-subject experiments in which I compared younger and older participants' willingness to help, phenomenological experiences, and their use of internal and external details after imagining future helping scenarios. Further, I manipulated key factors that influence episodic simulation to elucidate how episodic simulation abilities differ in novel scenarios, situations with which participants have personal experience, and under time constraints.

In Chapter 2, I examined whether episodic simulation of helping scenarios influenced younger and older adults' willingness to help others in COVID-related, compared to everyday scenarios. In addition to confirming that episodic simulation increases willingness to help in both age cohorts, I also demonstrated that imagining these scenarios increases subjective scene imagery, emotional concern, and perspective-taking (i.e., subjective theory of mind). Moreover, I also found that these phenomenological factors were strongly related to one's willingness to help, replicating and extending previous findings (Gaesser et al., 2017; Sawczak et al., 2019) to the highly novel scenarios posed by the COVID-19 pandemic.

Chapter 2 further extended previous literature (Addis et al., 2008; Schacter et al., 2013) demonstrating that older adults produce fewer internal details than younger adults when imagining future events. Specifically, the findings of Chapter 2 demonstrates that this pattern of results is robust enough to be found under the highly novel situations posed by the COVID-19 pandemic. Importantly, both younger and older adults were found to be more reliant on external details (including semantic information) when imagining unfamiliar scenarios. The findings that even younger adults exhibited reduced internal/episodic details when imagining highly novel scenarios supports the idea that we rely on external/semantic information when internal/episodic information is limited (Devitt et al., 2017).

In Chapter 3, I further expanded our understanding of how personal experience influences episodic future thought by examining whether participants' situation similarity ratings affected their willingness to help and phenomenological experiences, and whether this differed across younger and older adults. As expected, I found that both episodic simulation and participants' situation similarity ratings influenced their willingness to help people in need and phenomenological experiences. Critically, this study identified mechanistic differences between how one's previous experience influences younger and older adults' willingness to help. Specifically, situation similarity was found to influence willingness to help via scene imagery (a hallmark of episodic memory; Moscovitch et al., 2016) and perspective-taking in younger adults, but via perspective-taking alone in older adults. As such, the findings of Chapter 3 suggest that when episodic memory is inaccessible or impoverished (as it is thought to be the case in older adults) simulation of future events may depend on other processes.

Finally, in Chapter 4 I investigated whether time spent simulating future helping scenarios influenced younger and older adults' willingness to help, phenomenological experience, and the amount of episodic/internal detail used to describe their imagined events. Even when time spent simulating is relatively short (compared to the amount of time typically given to participants for future simulation; Gaesser et al., 2017; Addis et al., 2008; Chapter 2), younger and older adults still showed evidence of episodic simulation in the form of increased willingness to help, scene imagery, and perspective-taking. Notably, however, time spent imagining was associated with a greater *number* of internal details produced on episodic simulation trials. However, when verbal output was accounted for, by calculating the *proportion* of internal details (thought to be a more stable measure of episodic memory abilities; Lockrow et al., 2023), the effect of time was nullified.

Taken together, the studies presented in this thesis suggest that episodic simulation of helping behaviour is relatively preserved with age, although the neurocognitive mechanisms likely differ between older and younger adults. Interestingly, the current body of work finds considerable support for both the *constructive episodic simulation hypothesis* (which states that we draw on our previous experience to simulate the future; Schacter & Addis, 2007) and the semantic scaffolding hypothesis (which suggests that general knowledge provides a framework upon which events can be simulated; Irish, Addis, Hodges, & Piguet, 2012), supporting the idea that episodic and semantic memory work in concert to enable simulation of future events.

Younger and older adults can simulate future helping behaviours in everyday and COVID-related scenarios

Although episodic simulation enables people to imagine novel future scenarios (Schacter & Addis, 2007), the reliance on our past experiences to imagine the future suggests that there may be limitations on episodic simulation, especially when the scenarios to-be-simulated are highly novel. Indeed, research examining episodic simulation of unfamiliar scenarios often asks participants to imagine themselves in highly improbable situations (e.g., climbing Mount Everest; Arnold, McDermott, & Szpunar, 2011; de Vito et al., 2012; Wang et al., 2016). Imagining such unrealistic scenarios may be more difficult for older adults, given their declining cognitive control (Amer, Campbell, & Hasher, 2016) and the increased task demands involved in bringing together such disparate, unrelated information (Robin & Moscovitch, 2014).

Taking advantage of the highly novel scenarios posed by the COVID-19 pandemic, Chapter 2 examined episodic simulation of future helping behaviour in younger and older adults in situations for which they had little-to-no previous experience. Across a series of three studies, episodic simulation of helping behaviours reliably increased willingness to help (relative to the semantic control condition) in younger and older adults in both everyday and COVID-related scenarios. However, COVID-related scenarios were found to negatively impact the number of internal, episodic-like details produced by both younger and older adults, likely because they had no episodic memories of similar events to draw on. The lack of age interaction in this effect is striking given that older adults' greater reliance on semantic information is often attributed to age-related deficits in episodic memory. Indeed, the fact that both younger and older adults exhibit a comparable pattern when imagining scenarios for which they are unlikely to have memories, is consistent with the idea that impoverished episodic memory results in greater reliance on semantic information when imagining the future (Devitt et al., 2017). However, this highlights an important consideration in that events to-be-imagined must contain situations that are sufficiently familiar to older adults to ensure that their use of semantic, rather than episodic, details are not misattributed to failed memory retrieval.

The findings of Chapter 2 represent one of the first experiments to test individuals' ability to simulate scenarios related to an on-going global health crisis (cf., Sinclair et al., 2021), and thus provide important insight into promoting prosocial behaviour during similar crises. For instance, media outlets and charities could harness the robust effect of episodic simulation found here and frame stories of people in need in a way that encourages audiences to imagine themselves helping out. Furthermore, the findings of Chapter 2 demonstrate that younger and older adults do not necessarily need to have similar personal experiences to imagine vivid scenarios that shift their phenomenological experiences and willingness to help. Indeed, the plethora of non-episodic information available about COVID-19 through media sources likely provided enough general information for individuals to successfully simulate COVID-related scenarios, even if said events lacked rich episodic details when described.

Younger and older adults use different components of their previous experience to simulate future events

As discussed, the *constructive episodic simulation hypothesis* states that we draw on our previous experiences (episodic memories) and recombine details from lived events to simulate potential future scenarios (Schacter & Addis 2007; 2020). Indeed, familiarity seems to play a key role in future simulations and, like younger adults, older adults report more subjective scene detail when imagining events occurring at more familiar locations (i.e., landmarks; Robin& Moscovitch, 2017). Notably, the work in Chapter 2 demonstrates that episodic simulation of helping behaviour can increase younger and older adults' willingness to help in novel COVID-related scenarios, however, research specifically examining how older adults' use of lived experience in future simulations is limited.

Thus, one of the goals of Chapter 3 was to examine age-related differences in the use of previous experience to simulate future scenarios. Importantly, we piloted potential scenarios to ensure that there was sufficient variability in how similar our to-be-imagined events were to those personally experienced by younger and older adults. In addition to replicating the finding that episodic simulation increases willingness to help and phenomenological experiences irrespective of age, results from Chapter 3 also indicate that one's previous experience (as measured by participants' situation similarity ratings) predicted willingness to help and phenomenological experiences of simulated events.

Notably, a number of age-related effects were found in Chapter 3. Specifically, while participants' situation similarity ratings were predictive of scene vividness, the relationship between situation similarity and scene vividness was weaker in older adults, suggesting that even when situations were very similar to those older adults had personally experienced, their self-reported vividness of the imagined scene was impoverished. Indeed, given that scene vividness is considered to be a key component of successful episodic memory retrieval (Moscovitch et al., 2005), older adults' reduced scene vividness likely reflects age-related impairments in their episodic memory abilities.

Another goal of Chapter 3 was to examine how one's previous experience may influence imagined future intentions via different mechanisms in younger and older adults. I found that the relationship between participants' situation similarity ratings and willingness to help was mediated by scene vividness and perspective-taking in younger adults, but by perspective-taking alone in older adults. Taken together, the findings of Chapter 3 highlight the possibility that when episodic memory is inaccessible or impoverished, as it is thought to be the case in older adults, other components of one's previous experience may still influence future simulations. Additionally, it is possible that older adults use of perspective-taking may also be due to the nature of the to-be-simulated events. Indeed, older adults value prosociality, have been shown to prioritize the 'greater good' (Mayr & Freund, 2020), and thus may selectively engage with activities in this domain (Hess 2014; Hess & Ennis 2012). However, if this were the case, we may still expect scene imagery to play an indirect role, and for the use of perspective-taking to simply be larger than that seen in younger adults. However, given that parallel mediation within each age group separately found that the effect in older adults was not mediated by scene imagery, it is likely that the use of perspective-taking is at least partially compensatory.

Taken together, the findings from Chapters 2 and 3 expand our knowledge of what happens when younger and older adults simulate future scenarios with varying degrees of personal experience. This work also points to an important consideration when testing older adults' episodic simulation abilities: if older adults are asked to simulate future scenarios that are less familiar (but possibly more familiar to the young graduate students who designed them; Gaesser & Schacter, 2014), they may be at a disadvantage. Undoubtedly, such findings may also extend to other cognitive processes, particularly those that require episodic simulation (e.g., decision making and navigation; Hassabis & Maguire, 2007). Thus, care must be taken to ensure studies are designed to reflect the lived experiences of older adults to avoid overstating age-related decline in episodic simulation abilities.

Time spent imagining does not impact episodic simulation of helping behaviour in younger and older adults

As discussed, older adults produce fewer internal and more external details compared to younger adults when remembering the past and imagining personal future events (Addis et al., 2008). Moreover, this pattern has also been seen in means-end problem solving tasks, such that older (compared to younger) adults produce fewer internal details and relevant steps to solve common social problems (Sheldon et al., 2011; Vandermorris et al., 2013). While such findings may suggest impaired episodic memory and simulation abilities, a growing body of research (including the work presented in this thesis) suggests that older adults can successfully simulate future scenarios to solve social problems, at least when measured in terms of increased willingness to help (Gaesser et al., 2017; Sawczak et al., 2019).

A potential reason for this discrepancy is the increased time it takes for individuals to produce episodic, rather than semantic details. Indeed, retrieval is slower for episodic compared to semantic memories and the time difference is more pronounced in older adults (Spaniol et al., 2006). As such, older adults' reduced episodic and increased semantic details produced may be partially due to age-related declines in processing speed (Salthouse, 2010). However, studies exploring episodic simulation in younger and older adults do not typically account for age-related slowing (Addis et al., 2008; Gaesser et al., 2017; Chapter 2).

Thus, a goal of Chapter 4 was to examine whether time spent engaging in episodic simulation would influence willingness to help, various phenomenological experiences, and the number of internal details produced by younger and older adults. Although older adults reported less scene vividness than younger adults overall, my findings demonstrate that time spent imagining did not influence the effect of episodic simulation on younger and older adults' willingness to help or phenomenological experiences. Moreover, while the number of internal details was found to increase with the time spent imagining, this effect was nullified when internal details were represented as a proportion of overall details produced.

My findings demonstrate a critical difference in the effect of time spent imagining on the number of internal details produced (an often-used objective measure of episodic memory and simulation abilities; Addis et al., 2008) and one's subjective phenomenological experience of the imagined event. To date, existing 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). As such, much of the extant research is unable to draw conclusions on relationships between participants' subjective experience of imagined events and researchers' objective observations. Recent work examining the reliability of the

Autobiographical Interview suggests that proportional scores of internal details may provide more accurate accounts of one's episodic memory abilities (Lockrow et al., 2023). Given the discrepancy between subjective and objective measures found in Chapter 4 when using a count, but not a proportion of internal details, it is likely that proportional scores are also more appropriate in future simulations.

Conclusions and Future Directions

Taken together, the five studies covered in this thesis demonstrate that younger and older adults both successfully engage in episodic simulation, although the neurocognitive mechanisms may differ. As such, there are a number of important considerations for future research examining age-related changes simulation abilities. Firstly, novel events may similarly reduce younger and older adults' reliance on episodic memory during simulation. As such, it is important to gather information about participants' personal experience with the to-be-imagined events. Indeed, if older adults' have little-to-no personal experience with a to-be-imagined situation, they may be at a disadvantage, and their episodic simulation abilities are likely to be understated. Secondly, younger and older adults may use different mechanisms when drawing on their previous experiences, such that older adults may compensate for reduced episodic memory abilities by engaging in greater perspective-taking. To disentangle how the scene construction and perspective-taking components of future thought differ with age, future research should contrast older adults' ability to simulate scenarios that do and do not require 1) vivid scenes to be constructed, 2) taking the perspective of another individual (e.g., tasks involving navigation or decision making). For instance, the present paradigm could be adapted such that participants must imagine helping a person navigate to a destination or make an important decision. Finally, the present research also calls for further integration of scene construction and self-projection accounts of future thought (Hassabis & Maguire, 2007; Buckner & Carroll, 2007) into the *constructive episodic simulation hypothesis* (Schacter & Addis, 2007), which emphasizes the use of episodic memories to construct future events, and the semantic scaffolding hypothesis (Irish, Addis, Hodges, & Piguet, 2012), which emphasizes the use of semantic knowledge in constructing a framework upon which future events can be cast. The current results suggest that just as semantic knowledge can scaffold deficient episodic memory processes, preserved perspective-taking can compensate for deficient scene construction, at least when the simulated event requires perspective-taking. Given older adults' lifetime of experience and intact (or possibly even superior; Mayr & Freund, 2020) perspective-taking skills, they may be particularly well equipped to imagine helping others.

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