Exploring age-related differences in declarative memory retrieval using naturalistic paradigms

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Abstract

This thesis explores the nuances of the age-related differences in declarative memory recall, delving beyond the traditional characterisation of ageing as a process primarily marked by episodic memory decline and semantic knowledge preservation. The three experiments reported in the thesis manipulated retrieval instructions targeting episodic and semantic memories and examined participants' narratives by analysing the production of intermediate forms of declarative memories, particularly personal semantics and gist representations. The paradigms adopted across the three experiments involved narrative-like encoding by targeting personal events (Chapters 2 and 3) or adopting fictional stories (Chapter 4), followed by narrative-like retrieval, asking participants to remember and verbally describe these stories. In Chapter 2, the Semantic Autobiographical Interview (SAI) was introduced as a novel approach, enabling the exploration of episodic, personal semantic, and general semantic memory recall. Chapter 3 extended the exploration by investigating participants' adaptability in memory recall under changing task instructions. Participants were instructed to switch between the recall of unique and repeated events or to recall these memories in separate blocks. Chapter 4 introduced a naturalistic laboratory-based study involving video-based recall over varying time intervals, to investigate the emergence of gist in ageing and the consistency of recall over time. Across the three experiments, two consistent findings emerged: when elaborating autobiographical and fictional narratives, participants tended to recall a mixture of perceptual and contextually specific details but also gist-like and schematic information; older adults particularly preferred personal semantic knowledge (Chapters 2 and 3) and gist-like representations (Chapter 4) over more finer-grain details when recalling personal and fictional past experiences. Overall, this thesis uncovers a nuanced picture of age-related differences in declarative memory recall. It highlights the preference for personal semantic knowledge and gist-like representations in older adults' memories, shedding light on the interplay between different memory types and narrative preferences in ageing.

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Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others. The research presented in Chapter 2 has been previously presented as a poster (New Perspective in Declarative Memory conference 2022) and as a talk (Cambridge Memory Meeting 2021) and the manuscript has been submitted to a journal and is currently under review (Melega et al., 2023). The research presented in Chapter 3 has been previously presented as a poster at conferences (Cognitive Neuroscience Society 2022, British Association for Cognitive Neuroscience 2022) and the manuscript has been submitted to a scientific journal and it's currently under revision for re-submission (Melega & Renoult, 2023).

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Chapter 1

General Introduction

Our experience in the world is continuous, yet when we think back to our past, we tend to recall elements of this experience. We can think about unique events, re-constructing the spatial and temporal context and re-experiencing the perceptual details and emotions that characterized those experiences. For example, I could think about the sunny Sunday afternoon at the beginning of July that I spent swimming in the cold and clear water of a lake near Berlin. On other occasions, we may retrieve and share with others more general information about our personal experiences, like objective facts about ourselves or subjective personal opinions, as well as information about culturally shared knowledge. While at the lake, for example, I told my friend how much I like spending time in the water and that's why I usually go on holidays to the seaside in the summer holidays. The distinction between these two types of memory, episodic and semantic memory, was introduced by Endel Tulving in 1972 and influenced the investigation of these memory processes as separable and distinct constructs for decades.

Traditionally, the employment of laboratory-based methodologies, such as learning lists of words for testing episodic memory and vocabulary tests for semantic memory, supported the view of these memory types as highly distinct. Neuropsychological studies revealed dissociations in clinical populations, such as medial temporal lobe patients present difficulties in episodic memory with better preservation of semantic memory (Brandt et al., 2006; Manns et al., 2003; Vargha-Khadem et al., 1997; Warrington & McCarthy, 1988), while patients with semantic dementia generally have a preserved episodic memory (at least early on in the disease process) but impaired semantic knowledge (Hodges et al., 1994; Hodges et al., 1992; Maguire et al., 2010; Warrington, 1975). Research on ageing revealed a similar dissociation pattern, with a disproportionate decline in episodic memory relative to semantic and procedural memory (e.g., Leal & Yassa, 2015; Nyberg et al., 1996).

Although this distinction between episodic and semantic memory persisted as a fundamental framework for memory research, this view also evolved over time. In a later conceptualisation, Tulving recognised how episodic and semantic memory are *"closely interdependent and interact with one another virtually all the time*" (Tulving, 1983, page 65), emphasising how these processes are distinct yet connected. A growing body of literature has emerged, investigating the interdependences between episodic and semantic memory processes adopting laboratory-based and more naturalistic approaches, unveiling intermediate forms of declarative memory, such as *personal semantic memory*, the knowledge of our past (for a review, see Renoult et al., 2012), and *gist-like representations*, referring to general summaries of events (for a review, see Robin and Moscovitch, 2017). These intermediate forms of memory are particularly relevant in the context of ageing, where the boundaries between episodic and semantic memory are less defined than originally thought.

In the next sections of this introduction, I will give an overview of intermediate forms of memory, considering declarative memory as a dynamic system that transforms over time. I will then overview the importance of adopting naturalistic stimuli to explore life-like recall situations beyond the dichotomy between episodic and semantic memory.

Finally, I will characterise the age-related differences in memory retrieval, with particular emphasis on these intermediate forms of memory.

1.1. Declarative memory as a dynamic and multi-faceted system

The interplay between episodic and semantic memory processes is particularly relevant when considering declarative memory as a dynamic system, where memories can transform with time and experience (e.g., Dandolo & Schwabe, 2018). Several models of consolidation such as the standard consolidation theory (Squire, 1992; Squire et al., 2015), the multiple trace theory (MTT; Nadel & Moscovitch, 1997), the Fuzzy Trace Theory (FTT; Brainerd & Reyna, 2002), the Trace Transformation Theory (TTT; Moscovitch & Gilboa, 2021; Sekeres et al., 2018), or the Complementary Learning Systems (CLS; McClelland et al., 1995), theorized that memory representations are not static; instead, they vary over time. These theories are informed by human behaviour and animal research, where evidence showed how with time and experience episodic memories naturally tend to lose the more perceptual and context-specific details but retain the *gist* of the event, the knowledge of central elements describing the unfolding of the event (Bartlett, 1995; Schacter et al., 2012; Sekeres et al., 2018; note that memories can also retain their specificity over time; Alba & Hasher, 1983; Bonnici & Maguire, 2018; Evans & Fisher, 2011; Goldsmith et al., 2005; Reyna & Brainerd, 1995).

Memory transformation is not only about the loss of episodic details. Another process that occurs over time is the formation of *schemas*. When encountering similar events over time, we might construct schematic but dynamic representations of the common structure of similar events (for example, knowing what I usually do to get ready to go to work; Ghosh & Gilboa, 2014; Gilboa & Marlatte, 2017; Spalding et al., 2015; Van Kesteren et al., 2010; note that schemas may also be formed by the replay of a single event in the hippocampus after initial encoding, e.g. Kumaran et al., 2016). There are different degrees of abstraction in building schematic-like representations from personal experiences. For instance, we might retain a detailed representation of similar experiences, maintaining the perceptual and contextual characteristics of these *repeated events* (for example, remembering the situations in which I took the tram instead of cycling to work because it was raining; Conway & Pleydell-Pearce, 2000). These schemas and memory representations of repeated events can guide behaviour and help the individual adapt to different situations (e.g., taking the public transport when the weather is not good for cycling). In contrast, *self-knowledge*, referring to the subjective aspects of the self, like traits and preferences (for example, having a preference for cycling to work instead of taking public transports), and *autobiographical facts*, referring to more objective information about ourselves (for instance, knowing that I learned to ride my bike in primary school), would be more abstract types of self-schema and further detached from specific events (Klein & Lax, 2010). Not only personal but also *general semantic* information can emerge from past experiences but detached from the original context of acquisition (e.g., knowing that a tram runs on rails while a bus runs on wheels). However, some semantic concepts, such as names of people and locations, for instance, can retain their episodic origins or acquire episodic information during life experiences (Renoult et al., 2015; Snowden et al., 1996; Westmacott et al, 2001; Westmacott & Moscovitch, 2003).

These intermediate forms of declarative memory have recently received increased attention from cognitive researchers who recognise the dichotomic view of declarative memory as too simplistic to describe human recall behaviour (Greenberg & Verfaellie, 2010; Renoult et al., 2019; Irish & Vatansever, 2020; Rubin & Umanath, 2015).

1.2. Naturalistic approach to the study of declarative memory

The increased interest in targeting the nuances of memory processes in everyday life, highlighting the interplay between these memory components, motivates researchers to develop controlled yet naturalistic paradigms to better understand the complex human experience of remembering. Autobiographical memory studies are intrinsically ecologic, as they target real-life events that happened before the experiment. In autobiographical memory experiments, participants are usually instructed to think about personal unique experiences and to describe them in detail (Levine et al., 2002; Piolino et al., 2002; Kopelman et al., 1989; Williams & Broadbent, 1986). Among the tests and interviews designed and widely used to investigate autobiographical memory, the Autobiographical Memory Test (AMT; Williams & Broadbent, 1986) and the Autobiographical Interview (Levine et al., 2002) allow participants to elaborate a narrative describing past events. In the AMT, participants are required to describe these events in response to cue words and the narratives are categorised depending on their specificity. In the AI, participants are required to describe past events and are cued with time periods. Participants' narratives are usually analysed by segmenting the text into details categorised as *internal*, when referring to perceptual or contextual information of the event, or *external*, when referring to information that are non-episodic, such as semantic knowledge but also metacognitive statements and repetitions (Levine et al., 2002). Recently, this scoring approach has been adapted to disentangle among the intermediate forms of declarative memory, particularly by differentiating semantic and personal semantic details (Strikwerda-Brown et al., 2019; Renoult et al., 2020). As will be discussed later in this chapter, this adaptation allowed for an increased understanding of the age-related differences in declarative memory.

Regardless of the methodology adopted, what usually emerges from these experiments are personal stories, or personal narratives, that re-construct the selected experience by linking together people, contextual details and happenings that unfold over time. The downside of autobiographical memory studies is the lack of encoding control over the events recalled by participants. To overcome this limitation, researchers have recently started to design experiments where participants use wearable cameras or smartphones to record personal experiences (Bainbridge & Baker, 2022; Hoefeijzers et al., 2019; Levine et al., 2004; Martin et al., 2022) and verifiable real-world encoding paradigms to check the accuracy of the later retrieved memories (Diamond et al., 2018; Diamond et al., 2020; Griffiths et al., 2016; Nielson et al., 2015; St. Jacques et al, 2008; Jeunehomme et al., 2018).

Beyond autobiographical memory, researchers use visual and verbal narratives, such as short videos and written stories, as encoding material (for a review on the importance of narratives on memory studies see Lee & Chen, 2020). One benefit is the ecological validity. At encoding, they provide a realistic experience due to the series of events that coherently unfold over time. At retrieval, they can be shared with others, maintaining their narrative form, resembling the narrativization of the past typical of traditional autobiographical memory studies (Hasson et al., 2008; Hasson et al., 2004;

Kurby & Zacks, 2018; Kurby & Zacks, 2019; Sargent et al., 2013; Wahlheim & Zacks, 2019). Paradigms involving these naturalistic stimuli often require participants to pay attention to the videos or text as they would do in their everyday life, then to describe in detail what they remember seeing.

These naturalistic stimuli have been widely used in healthy young adults to characterise memory consolidation and transformation processes over time, as well as their neural correlates. In these studies, participants usually viewed film clips or read written narratives and then were asked to recall their content at different delays (e.g., Bird et al. 2015; Sekeres et al., 2016; Oedekoven et al., 2017). The findings revealed how participants recall fewer perceptual and contextual information over time (Sekeres et al., 2016) and also how they tend to make more false recognition of details similar to those of the original narrative (Furman et al., 2007). Alongside the loss of some perceptual details over time (named *peripheral* details), the *central* elements reflecting higher level plot information, the gist of the story, is typically retained and consolidated (Reyna & Brainerd, 2002; Sekeres et al., 2016; Wiltgen & Silva, 2007; Winocur & Moscovitch, 2011). This disruption of peripheral and contextual details compared to central details, is more commonly observed after long delays (days or weeks) than short delays from encoding (minutes or hours). In fact, in these studies, while retrieval of previously seen stimuli such as videos included elevated perceptual and contextual details within the same day of encoding, at a week's delay, the memory for these details was reduced (Bird et al. 2015; Sekeres et al., 2016). This time-dependent loss of perceptual details, however, can be prevented by actively recalling an event (e.g., Carpenter et al., 2008; Sekeres et al., 2016; Sacripante et al., 2023; for a review, see Roediger & Butler, 2011). Thus, repeated recall may support consolidation by strengthening and stabilizing memory representations (Antony et al., 2017).

1.3. Declarative memory changes in ageing

Despite their high similarity to real-life experiences, naturalistic stimuli have less often been used to investigate memory changes in ageing. Findings from studies adopting videos as encoding material are similar to those requiring participants to recall autobiographical memories. Indeed, while older adults retain the gist and the central elements of the events, the recall and recognition of perceptual details is reduced compared to young adults (Sacripante et al., 2019; Davis et al., 2021; Delarazan et al., 2023; Taler et al., 2021).

A wider literature exists on age-related changes during autobiographical memory retrieval. It is widely accepted that older adults tend to recall past events with fewer episodic details, such as perceptual and contextual details, and more semantic information, even when explicitly instructed to provide memories of unique episodes (e.g. Addis et al., 2008; Acevedo-Molina et., 2020; Levine et al., 2002; Renoult et al., 2020; St-Jacques & Levine, 2007; Strikwerda-Brown et al., 2018; but see Mair et al., 2021 for differences depending on the test adopted). Different interpretations for this pattern of results emerged over the years. One interpretation considers the higher production of semantic content in ageing as a compensation for recollections of past events that are impoverished due to an episodic memory decline that naturally occurs with age (Devitt et al., 2017). Another potential explanation is related to the reduced cognitive control abilities in ageing, resulting in memory representations more reliant on prior semantic knowledge (Craik & Bialystok, 2006; Spreng et al., 2018; Turner & Spreng, 2015) and characterised by an increase of non-episodic information due to a decline in inhibitory mechanisms (Amer et al., 2019; Amer et al., 2022). Beyond cognitive decline, the tendency of older adults' to include more story-aside might be related to more general changes in narrative styles (Bluck et al., 1999; Bluck et al., 2016; see also Schacter et al., 2012) and communicative goals (Trunk & Abrams, 2009; Madore et al., 2014).

A recent perspective considers the age-related changes in recall from a positive point of view, describing a natural shift from detailed representations towards the gist and general meaning of experiences (Grilli & Sheldon, 2022). This interpretation is informed by an increased attention towards intermediate forms of declarative memory, particularly gist and personal semantics. A recent study adopting the novel scoring approach that allows to disentangle between the different forms of semantic memory, revealed that older adults' narratives of the past are rich in personal semantic memories, particularly autobiographical facts and self-knowledge information (Renoult et al., 2020). Additionally, older adults' narratives were found to be characterised by higher variety of topics in comparison to young adults (Sheldon et al., 2023).

Regardless of the interpretative framework adopted, findings from behavioural studies revealed how different types of semantic knowledge emerge from personal experiences and are integrated in participants' narratives. Although this is particularly evident in older adults, studies of autobiographical memory tend to mainly focus on episodic recollections, and methodologies developed to investigate episodic and semantic memory in parallel, as well as their intermediate forms, are still rare (but see Addis et al., 2008; Acevedo-Molina et al., 2020; Strikwerda-Brown et al., 2022; Madore et al., 2014).

Rare are also methodologies that investigate how individuals can flexibly retrieve episodic or semantic memories, and switch between these retrieval modes. Nevertheless, there is emerging evidence that the type of declarative memory recalled also depends on control processes and contextual factors, including the specific task demands (see Renoult et al., 2019). For example, while young adults flexibly modify the content of their narratives depending on the specific task demands, older adults present more difficulties to adapt to the instructions (Madore et al., 2014; Strikwerda-Brown et al., 2021; Ford et al., 2014). The development of novel approaches is thus necessary to increase our understanding of how the different memory types interact when participants elaborate narratives about autobiographical or fictional events, or recall more general knowledge.

1.4. Overview of the studies

In this chapter, I have presented evidence that individuals tend to construct autobiographical and fictional narratives combining perceptual and contextually specific detailed with gist-like and schematic information. This mixture of different types of details and content is particularly evident in older adults' narratives. Building upon the reviewed literature, the primary goal of the present thesis is to better understand and characterise the nuances of age-related differences in declarative memory recall. From a methodological perspective, I adopted a naturalistic approach to study declarative memory and developed new paradigms with narrative-like encoding, using personal and fictional stories, as well as a narrative-like structure at retrieval, asking participants to verbally describe these stories. In particular, I have designed two autobiographical memory tasks that tap into participants' real-life experiences (Chapter 2 and Chapter 3) and a laboratory-based yet naturalistic task that uses videos at encoding to simulate the continuity and complexity of real-life experiences, but with additional control over encoding (Chapter 4).

In Chapter 2, I introduced a new version of the Autobiographical Interview (AI, Levine et al., 2002), the Semantic Autobiographical Interview (SAI), designed to target semantic memory alongside episodic memory. In the traditional AI, the semantic details that participants naturally include in the elaboration of episodic memories are only incidental, as not probed by instructions. Thus, while episodic details can be considered a consistent measure of episodic memory processes, the semantic details should not be held as a measure of semantic processing (see also Simpson et al., 2023 for a meta-analysis of the Autobiographical Interview). This is evident when considering that young adults, who are expected to have no impairment in semantic memory, typically present a low production of semantic details. Thus, to have a better characterisation of the typical increase in semantic production during episodic recollections in ageing, and disentangle among the possible interpretation for this behavioural manifestation, it is necessary to develop an interview specifically designed for targeting personal and general semantic memory (Renoult et al. 2020; Simpson et al., 2023). We designed the SAI with the aim of investigating episodic, personal semantic and general semantic with a similar approach, asking participants to recall these memories in a narrative form. As will be explained in more details in the next chapter, participants were instructed to verbally describe either a specific event, a period of their life or an historical period in response to a specific temporal cue. Interviews were then segmented into details categorised as episodic, personal or general semantic (Levine et al., 2002; Renoult et al., 2020). We hypothesized that the age-difference in memory recall would be reduced in the personal and general semantic memory recall, when the interview targets a cognitive processing style that is better suited for older adults (Grilli & Sheldon, 2022).

Having investigated age-differences with an experiment that targets episodic and semantic memory processes in different sections of the interview (the AI and the SAI) in Chapter 2, in Chapter 3 I present the result of a study that looked at the flexible recall of different types of memories depending on dynamic changes in instruction. Previous research suggested that the type of memory recalled depends on control processes and contextual factors, including the specific task demands (see Renoult et al., 2019). Here, we aimed to investigate whether older adults adapt their recollection to increased task-demands less effectively than young adults. We used an adapted version of the Autobiographical Memory Test (AMT; Williams & Broadbent, 1986), where participants are instructed to describe a unique memory in response of a cue-word, and the Alternate Instruction Autobiographical Memory Test (AMT-AI; Dritschel et al., 2014), where participants are instructed to switch between an episodic and a semantic retrieval mode. The goal of this study was to investigate whether the pattern of declarative memory recall typical of ageing, characterised by narratives with more semantic details, is influenced by increased demands on executive functions. Our expectation was that older adults would be more affected by switching between episodic and semantic retrieval modes due to their reduced flexibility in modulating recollection and the increased cognitive costs associated with task switching (e.g., Ford et al., 2014; Strikwerda-Brown et al., 2021; for a review see Wasylyshyn et al., 2011).

Although autobiographical memory studies are highly ecological, they lack control over encoding. To overcome this limitation, I designed a naturalistic yet laboratory-based study that is presented in Chapter 4. Within this study, participants viewed a series of videos and then recalled the content of the videos at different time points. Critically, half of the videos were recalled multiple times (immediately after encoding, after one day, and after one week) while the other half were only retrieved one week after encoding, allowing to dissociate the effects of time and repeated recalls on declarative memory recall in ageing. Findings from literature revealed age-differences in the production of peripheral details, while the central elements and more general meaning of events, are similarly recalled by young and older adults (Sacripante et al., 2019; Davis et al., 2021; Delarazan et al., 2023; Taler et al., 2021). One potential interpretation of these results is that older adults process the narrative structure of an event in a manner similar to young adults. To investigate this possibility, in addition to analyse the transformation of central and peripheral details over time, we transformed the narratives into a network of events based on semantic similarity. Given the increased reliance on the gist of a memory representation over time (e.g., Winocur & Moscovitch, 2011) and particularly in older adults (for a review see Grilli & Sheldon, 2022), we hypothesized that the semantic structure of an experience would similarly influence recall in young and older adults, both immediately after encoding and after a period of consolidation.

Chapter 2

Evoking episodic and semantic details with instructional manipulation in young and older adults

2.1. Introduction

Autobiographical remembering varies on a continuum from highly detailed episodic memories to more abstract and general forms of personal semantic knowledge (Conway, 2009; Irish & Piguet, 2013; Renoult et al., 2012). Several memory tests allow a naturalistic evaluation of human memory via the recall of personal narratives, typically instructing participants to recall specific past events (e.g., "I remember the last time I went on campus before lockdown"; e.g., Kopelman et al., 1989; Levine et al., 2002; Williams & Broadbent, 1986). Although the instructions require participants to recall unique events, the narratives usually include not only episodic details (e.g., "there was a blue table on the left") but also non-episodic information, such as personal knowledge about one's life circumstances (e.g., "I used to cycle to campus") or general knowledge about the world (e.g., "Covid hit the world in 2019"; Renoult et al., 2020; Strikwerda-Brown et al., 2019).

Research in aging adopting these naturalistic tests revealed that elderly individuals tend to describe experiences from their past differently than do young adults (for a review, see Schacter et al., 2013). In particular, older adults' narratives are characterized by a reduction in episodic details, such as spatiotemporal and contextually specific information, and an increase in non-episodic details, particularly semantic knowledge (e.g., Addis et al., 2008; Levine et al., 2002; St. Jacques & Levine, 2007; Piolino et al., 2002). While the interpretation of the reduced episodic details has been transparently interpreted within the episodic memory decline typical of aging (see Simpson et al., 2023 for a review), the interpretation of the increased production of semantic details, is not as straightforward. Crucially, as these semantic details are incidental or unprompted in the instruction, they cannot be taken to directly assess semantic processing capacity, as illustrated by the fact that they are sparsest in healthy young participants who presumably have intact semantic processing.

Various explanations for this shift from episodic to semantic detail production in aging have been proposed. Older adults may produce more semantic content in their narratives to compensate for episodic recollections that are impoverished (Devitt et al., 2017). This interpretation is in line with the episodic decline typical of aging that occurs alongside preserved semantic processing, resulting in narratives that are lacking in episodic details but are rich in semantic information (e.g., Levine et al., 2002). Nevertheless, the connection between the production of episodic and semantic elements has not been consistently established. Some studies reported no reduction in episodic details but only an increase in semantic production in aging (e.g., Aizpurua & Koutstaal, 2015; Mair et al., 2017). Moreover, a recent study showed how the relationship between the production of episodic and semantic details could vary across different episodic memory tasks (Mair et al., 2021). Thus, although a compensatory mechanism may be present, additional mechanisms are likely to be involved.

Another potential explanation for the shift from episodic to semantic detail production in aging suggests a general shift from fluid abilities, dependent on flexible cognitive control, towards more crystalized cognition in older adults, reliant on prior semantic knowledge (Craik & Bialystok, 2006; Spreng et al., 2018; Turner & Spreng, 2015). Support for this interpretation comes from studies that reported an association between the production of episodic details and measures of executive functions (e.g., Piolino et al., 2010; see Wilson & Gregory, 2018 for a review).

A related perspective on the relevance of reduced efficiency of cognitive control describes older adults' recollections as more cluttered and containing more non-target information due to a decline in inhibitory mechanisms (Amer et al., 2019; Amer et al., 2022). This decline prevents older adults from inhibiting irrelevant information such as semantic knowledge which, according to a hierarchical view of the organization of autobiographical information, would be easier to recall than episodic information (Conway & Pleydell-Pearce, 2000). As a result, while young adults flexibly modify the content of their narratives depending on the specific task demands, older adults may struggle to adapt to the instructions (Ford et al., 2014; Madore et al., 2014; Strikwerda-Brown et al., 2021).

Beyond these interpretations, age-related differences in declarative memory and cognitive control are intertwined with different narrative styles (Bluck et al., 1999; Bluck et al., 2016; see also Schacter et al., 2012) and communicative goals (Madore et al., 2014; Trunk & Abrams, 2009). According to this view, information considered as off-target, as not directly probed by instruction, reflects a broader approach to memory retrieval where older adults might include more *story-aside* to provide context to the listener (Bluck et al., 2016) as well as to support the sense of self (Pasupathi & Mansour, 2006). The focus of this interpretation thus moves away from a view of age-related differences based on cognitive decline and compensatory mechanisms, reflecting on how narrative style may differ in aging.

A recent interpretation similarly reframes the age-related differences in autobiographical recall, shifting away from a deficit-centered approach to emphasize the positive transformations that come with age. This interpretation suggests a transition in memory representation from highly specific to more gist-like (Grilli & Sheldon, 2022). Focusing more on gist and general meaning may become natural in aging and in turn may promote the elaboration of narratives with a higher variety of topics in comparison to young adults (Sheldon et al., 2023). Accordingly, connections with other meaningful information may be prioritized over describing additional perceptual and contextual information related to the event. This is consistent with the observation that older adults' autobiographical memories are rich in meaningful autobiographical facts, which refer to objective elements of our past and information about close others, and self-knowledge information, referring to the more subjective aspects such as personality traits and attributes (Renoult et al., 2020).

2.1.1. Current study

In the present study, we explored differences in autobiographical memory recall between young and older adults, specifically focusing on how they access and describe personal and general semantic memories when explicitly instructed to do so. Understanding whether the age differences documented when participants are required to describe events from their past also emerge when required to produce personal and semantic knowledge, may help to disentangle and provide further insights into the various explanations for the shift from episodic to semantic memory in aging.

To do so, we designed a new version of the Autobiographical Interview (AI; Levine et al., 2002) that directly targets personal and general semantic knowledge, alongside episodic memory, in different sections of the interview. In the AI, participants are instructed to describe in detail unique events from their past and then are probed with specific questions designed to elicit additional episodic information related to the event that was not spontaneously recalled. In the personal semantic section (P-SAI), participants were asked to provide a brief overview of what a specific period of their life was like for them, while in the general semantic section (G-SAI) they were instructed to describe what was going on in their community, country and/or in the world at that time. The specific probing then included questions that target specific types of personal knowledge and general knowledge, based on our taxonomy (Renoult et al., 2012; Renoult et al., 2020). Narratives were then scored to identify and categorize episodic information and different subtypes of semantic details, such as general semantic knowledge and various forms of personal semantic details (Renoult et al., 2020).

Our investigation focuses on the occurrence of different types of details across the distinct sections of the interview. We were interested in the overall production of probed details, those coherent with the instructions, across interviews (for example the presence of general semantic knowledge in the general semantic section of the interview, or of episodic details in the classic autobiographical interview) as a measure of on-task recall. Elevation of non-probed details in older adults' narratives across sections would be consistent with a decline in cognitive control and inhibitory mechanisms (Amer et al., 2018; Amer et al., 2022; Spreng et al., 2018). A compensatory mechanism, such as an increased production of semantic information to overcome the impoverished episodic recollections (Devitt et al., 2017), would not be required to explain such findings, as the elevation in non-probed details may reflect a trait-like inability to adhere to task instructions regardless the type of memory recalled. Conversely, an absence of age differences, or facilitation for older adults, in the semantic sections of the interviews would support an interpretation that goes beyond cognitive decline and a less flexible adaptation to task instruction, showing a preference towards the recall of gist-like information when older adults remember the past (e.g., Grilli & Sheldon, 2022).

2.2. Methods

2.2.1. Participants

Fifty-two young and older adults took part in the study. This sample size was based on previous work investigating autobiographical memories using different tasks and interviews (Acevedo-Molina et al., 2020; Levine et al., 2002; Madore et al., 2014; Piolino et al., 2002). 26 young adults (19 female, 7 male) were undergraduate psychology students from the University of East Anglia recruited online and awarded with course credits. 26 older adults (20 female, 6 male) were recruited through a local cohort and received an e-voucher as compensation for their participation. Participants were native English speakers or learnt English as a very young child. Participants were screened for neurological, psychiatric and medical conditions known to compromise brain function and older adults completed the Addenbrooke's Cognitive Examination (ACE-III; Hsieh et al., 2013) as neuropsychological assessment for global cognition. In addition, participants completed a neuropsychological assessment for specific cognitive domains (see **Table 2.1** for demographic and neuropsychological tests results), including Wechsler's digit span backwards test (1987), the trail making test parts A and B (Reitan et al., 1958) and a word recognition and source memory test. These cognitive tests were completed using the online platform NeurOn (https://neuropsychology.online/). After screening, one older adult was excluded as not meeting eligibility criteria (as scoring below the threshold of 88 for the ACE; Mioshi et al., 2006). Among the sample of young adults, two participants were excluded due to the poor audio quality of the recorded interviews. The final sample included 25 older adults (18 female, 7 male) and 24 young adults (18 female, 6 male) that were matched in education level. Data was collected online between 2019 and 2022. All participants provided informed consent before undergoing the experiment. The study received ethics approval from the Research Ethics Committee of the School of Psychology at the University of East Anglia (Title: Examining personal semantics within the autobiographical interview; Project reference: 2019-0174-001555).

Table 2. 1. Participants demographic and neuropsychological assessment

	Older		Young	
	M	SD	M	SD
Age in years	70.04 (range 61-83)	5.73	21.29* (range 18-27)	2.14
Education in years	13.76	2.3	13.46	1.64
ACE	95.92	2.74	-	-
PHQ-9	1.4	2	2.88	2.89
GAD-7	1	1.71	2.96	3.47
PSQI	4	1.89	4.36	2.5
Trail making B-A time	18.45	15.57	13.2	21.7
Digit span backwards	5.72	1.59	5.35	1.26
Episodic memory:				
Recognition (d')	-.13	1.66	-.008	1.77
Source Memory (Hits)	59.81	19.39	56.61	20.81

*Note. In the episodic memory test, the scores refer to the mean percentage of responses. ACE = Addenbrooke's Cognitive Examination; PHQ9 = Patient Health Questionnaire; GAD7 = Generalized Anxiety Disorder Assessment; PSQI = Pittsburgh Sleep Quality Index; d-prime was calculated as the difference between the z-score of hits and z-score of false alarm. * The difference between groups is significant (p < .001).*

2.2.2. Materials

2.2.2.1. Life chapter listing and selection

To facilitate access to episodic and personal semantic information and the elaboration of narratives about the past self, we used personalized life periods as cues to evoke narrative content (Conway & Pleydell-Pearce, 2000; for a similar approach, see Acevedo-Molina et al., 2020). Older adults were instructed to segment the last 30 years of their life story into chapters, whereas, young adults were asked to list personal chapters from their entire life. All participants were instructed to list as many chapters as they wanted, provided that the chapters were of 1-5 years in length. Each chapter was assigned a title and beginning and end dates. The over-specification of chapters provided an overall context for life-chapter definition and reduced the extent of selective memory reactivation prior to the interview. At test, one recent life chapter that included the past year (recent time period) and one chapter from 10 years ago (remote time period) were selected. If multiple chapters were listed for the same years (e.g., 10 years ago), participants were required to select the chapter they were more comfortable describing.

Autobiographical narratives were garnered following the general procedures of the Autobiographical Interview (AI; Levine et al., 2002), including a free recall phase, a general probe phase for clarification of instructions (where necessary) and encouragement to provide more details, and a specific probe phase in which cues corresponded to discrete content categories. The specific probe phase was conducted after the free recall and general probe responses were collected for both recent and remote memories. We administered three versions of the AI: the standard version with episodic cues (specific events) and two new versions with general and semantic cues.

2.2.2.2. Autobiographical Interview (AI; standard version; Levine et al., 2002)

Participants were asked to describe in detail a specific event from each life chapter selected. Specific probe cues elicited spatiotemporal, perceptual and emotional details regarding the event.

2.2.2.3. Semantic Autobiographical Interview

The Semantic Autobiographical Interview (SAI) includes a Personal Semantic Autobiographical Interview (P-SAI) and a General Semantic Autobiographical Interview (G-SAI).

Personal Semantic Autobiographical Interview. Personal semantic memory, conceptualized as the knowledge of one's personal past (e.g., Renoult et al., 2012; Renoult et al., 2020), was probed for the same time periods as used for the original AI. Participants were instructed to describe what was going on in their life during a particular chapter (instruction: "If you wanted to tell someone how the *early retirement* chapter was like for you, what would you say?"; for more detailed instructions, see the supplementary materials in the Appendix on page 160). The specific probes were based on the taxonomy from Renoult and colleagues (2012) and targeted autobiographical facts (important facts, people and places), repeated events (weekly habits and routines, hobbies, other relevant activities) and self-knowledge information (personality traits and character, opinions and beliefs, preferences). The order of specific probes was randomized across participants (for full instructions, see the supplementary materials in the Appendix on page 160).

General Semantic Autobiographical Interview. Participants were instructed to recall general semantic information, conceptualized as culturally-shared general knowledge (e.g., Tulving et al., 2002). In this section of the interview, participants were asked to describe what was going on locally, in their country and/or in the world, focusing on public events, famous people and popular culture in general (instructions: "If you wanted to tell someone what was going on in your community, in UK or in the world *during the last year*, what would you say?"; for more detailed instructions, see the supplementary materials in the Appendix on page 160). In the specific probe phase of the interview, participants answered specific questions about public events, famous people, trends and other things that were popular during the last year (for full instructions, see the supplementary materials in the Appendix on page 160). As young adults had less exposure to general semantic information about the remote time period (that would have typically corresponded to age 10-12 for them), we restricted this section of the interview to the recent time period (i.e., last year).

2.2.3. Design and procedure

The experiment was conducted online over three sessions for older adults (first: collection of demographic and health information and life chapters – duration was about 20 minutes; second: neuropsychological testing – duration was about 1 hour; third: autobiographical and semantic interviews – duration was about 2 hours) and two for young adults (first: collection of demographic and health information and life chapters – duration was about 20 minutes; second: autobiographical and semantic interviews, and neuropsychological testing – duration was about 2 hours). Initially, participants received a link for completing a series of questionnaires on Qualtrics (Qualtrics International, Inc., Provo), including the listing of personal life chapters. After giving consent, participants completed the Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001), the Generalized Anxiety Disorder Assessment (GAD7; Spitzer et al., 2006), and the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) to control for potential group differences that could explain our pattern of results in memory recall. Then, participants were instructed to list personal chapters from their life (see section on "Life Chapter Listing and Selection" for more information). Older adults were then contacted to complete a screening for global cognition (ACE-III test) and a neuropsychological assessment for specific domains on a video call on Microsoft Teams with the experimenter. Young adults completed the neuropsychological assessment for specific domains at the end of the autobiographical and semantic interviews. The choice of adding a session for older adults was to avoid fatigue due to the long testing sessions and to increase the time available in case of technical issues. One week after completing the online questionnaires, participants were invited to a video call on Microsoft Teams to complete the original AI and the personal semantic section of the Semantic Autobiographical Interview (P-SAI), administered in a counterbalanced order, followed by the general semantic section of the Semantic Autobiographical Interview (G-SAI), which was always administered last to avoid shifting between personal (episodic and semantic) content and general semantic content. At the beginning of the session, participants selected two chapters (a recent and a remote one) from those previously listed to be used as personalized temporal cues for memories in the different sections of the interview.

2.2.4. Details scoring

All recorded interviews were automatically transcribed offline, using Word Online, and then manually edited by two researchers (G.M. and F.L.). Memories were scored following an adapted method described in the original AI study (Levine et al., 2002) and in a more recently described taxonomy of semantic details (Renoult et al., 2020). Transcripts of memories were segmented into details and classified as Episodic, Autobiographical Facts, Self-knowledge, Repeated Events, General Semantic, Repetitions or Other. Episodic details refer to unique events, including spatial-temporal, perceptual and emotional information. Autobiographical Facts include basic objective information about the personal past, objective elements of our past, resembling a skeletal autobiography. Self-knowledge reflects personality traits and character, including also personal opinions and beliefs. Repeated events represent common elements of repeated episodes. General semantic includes culturally shared knowledge. Finally, repetitions are considered as a separate category, while metacognitive statements are details that do not belong to a specific category and are scored as "other". A description of the scoring rules with examples is presented in **Table 2.2**. For simplicity, we report analyses conducted on cumulative (Free Recall + General Probe + Specific Probe) scores (for analysis of free recall only, see the supplementary materials in the Appendix from page 168).

Memories were scored by two independent raters (G.M. and F.L.), after completing a training on the AI scoring methodology and the new scoring scheme for semantic details, using the material provided by B.L. (the main developer of the AI). In addition, eight memories for the original AI, eight for the P-SAI, and four for the G-SAI were used as additional practice and scored by both researchers. The remaining memories were assigned to the scorers in a pseudo random order such that time periods and age groups was equally represented. Scorers were only given the list of memories with an ID, without indication of the age group. We followed suggestions from Wardel and colleagues (2021) to facilitate scoring and reduce human error, using keyboard shortcuts for labelling detail type and an automated approach for summing the labelled details developing in MATLAB (Mathworks, Inc), a script for this purpose is available at https://osf.io/srw2c/.

Table 2. 2. Summary of scoring rules and examples.

Detail Type	Definition	Examples
Episodic	Unfolding of the event, spatiotemporal, perceptual and emotional details	*Last week I went to the mountains; I was very happy; There was a blue table on the left.*
Autobiographical Fact	Basic (objective) information about personal life circumstances, factual element of unique episodes	*I live in Norwich; I have a younger sister.*
Self-Knowledge	Personality traits and character, opinions and beliefs	*I was very shy at that age; I am not fond of the weather in the UK*
Repeated Event	Common elements of repeated episodes	*I go climbing every Thursday; In the summer I cycle to the office every day*
General Semantic	Culturally shared knowledge (e.g., neighbor community, country, world)	*Last year Covid hit the world;*
Repetition	Information that have already been recalled	*As I said, Covid hit the world last year*
Other	Metacognitive statements and editorializing	*Let me think about it; I can try to guess, but no I don't remember anything else.*

2.2.4.1. Reliability of scoring protocol

To assess reliability, 16 memories for the original AI (16.33% of the total AI), 16 of the P-SAI (16.33%) and 8 of the G-SAI (16.33%) were randomly selected to be scored by both scorers, who were blinded to which memories were used to calculate the reliability. Inter-rater reliability was calculated separately for each interview with the Intraclass correlation coefficient (ICC; two-way, random effects model). Considering each details category separately, inter-rater reliability was very good to excellent across interviews (all ICCs for the AI >.86, all ICCs for the P-SAI >.85; all ICCs for the G-SAI > .83).

2.2.5. Data processing and statistical analysis

Scored data and analysis code are available at https://osf.io/srw2c/ (raw data could not be released as these data could not be fully anonymized). This study's design and its analysis were not pre-registered. Data were analysed using the R statistical software version 4.1.2. (R Core Team, 2020).

Prior to the analysis, due to a positive skewness that is typical of narratives, we applied a winsorization procedure to all memories to rescale detail counts exceeding +/- 2.5 SD from the mean to be 2.5 SD from the mean (McKinnon et al., 2008; McKinnon et al., 2015). Detail counts were averaged across recent and remote memories, as the time period did not reveal to be a significant factor in the analysis. To account for the longer narratives consistently provided by older adults than young adults in the AI (*Mdn* = 115 vs. 70 for older vs. young for total number of details, $U = 457$, $p = 0.002$, $rg = -0.86$, 95% CI [16, 56.5]) and P-SAI (*Mdn* = 174 vs. 114 for older vs. young for total number of details, $U = 488$, $p < 0.001$, $rg = 0.53$, 95% CI [29, 88.5]), but not in the G-SAI (*Mdn* = 61 vs. 50.5 for older vs. young for total number of details, $p = 0.24$) we focused on proportional scores (i.e. the identified detail type divided by the total number of details) in participants' narratives as our measure of interest (for detail counts analyses, see the supplementary materials in the Appendix from page 163). "Target" detail scores for each interview were calculated for each participant by dividing the elicited detail category (i.e., episodic for the AI, personal semantic [autobiographical facts, self-knowledge, and repeated events] for the P-SAI, and general semantic for the G-SAI) by the total number of details. We assessed production of target details (i.e., episodic for the AI and personal semantic or general semantic for the SAI) across the three interviews, followed by differences in the elaboration of specific details type (episodic, personal semantic general semantic, repetition, other) within each interview. Rank-order correlations of the proportion of target details recalled across interviews were used to assess the consistency of individual differences in recall given the different instructional manipulations. Scores were analysed in mixed (Score Type X Group) ANOVAs. In addition to counterbalancing the administration of the AI and the P-SAI, we checked for order effects including order as a factor in the analysis and found no significant effect (p = 0.12). Due to the non-normal distribution of the data and different variance between age groups, we also ran mixed ANOVAs using permutation tests as a non-parametric approach, where the proportion of details were randomly permuted across the young and older adults' participants (see Grilli & Verfaellie, 2016). The F statistics was then recomputed for the permuted data set and the procedure was repeated 1000 times to generate a non-parametric distribution of F values for main effects and interactions. Main effects and interactions in the original data were significant when the new computed F value fell in the top 5% of the distribution for that particular effect (Grilli & Verfaellie, 2016; Konkel et al., 2008). As results were consistent across both parametric and non-parametric analyses, only the parametric ones are reported. We used Mann–Whitney U test as pairwise comparisons between detail type and group that we corrected for false discovery rate of multiple comparisons (Benjamini & Hochberg, 1995). We also conducted a power analysis to compare the statistical power of our study with the original AI study (Levine et al., 2002) that also utilized the proportion of details as a measure of autobiographical recall. According to a G*Power analysis (Version 3.1.9.4; Faul et al., 2007), the statistical power for the proportion of internal details was high at 0.99 with 15 participants per group in Levine and colleagues' (2002) study. Our study, with 25 older and 24 young adults, yielded a statistical power of 0.72, still indicating a moderate statistical power. Additionally, we calculated the statistical power for the proportion of semantic-on-total details from the re-analysis of external details conducted by Renoult and colleagues (2020). We focused on the spontaneous recall (free recall and general probe) as one of the studies included did not collect specific probe information (St. Jacques & Levine, 2007). The statistical power for the proportion of semantic details was 0.99 with 30 participants per group (from Renoult et al., 2020). Our study achieved a similar high statistical power of 0.96.

2.3. Results

2.3.1. Age differences in the production of target recall across interviews

As seen in **Figure 2.1**, participants generally oriented their narrative production to produce target details in alignment with instructions. There was a larger range of target detail production across groups for the AI and P-SAI, with the target detail production on the G-SAI lower than for the other two AI versions. These observations were supported by a main effect of interview ($F(2,141) = 101.1$, $p < 0.001$, ηp2 = 0.59, 95% CI [0.51, 1.00]) such that the P-SAI had a higher proportion of target details (Median = 0.78) than the G-SAI (*Mdn* = 0.53, *U = 2064, p* < 0.001, *rg* = -0.92, 95% CI [0.12, 0.22]) and the standard AI (*Mdn* = 0.69, *U = 144, p* < 0.001, *rg* = -0.64, 95% CI [-0.12, -0.06]). Young adults generally produced a higher proportion of target details (*Mdn* = 0.72) than older adults (*Mdn* = 0.67, *F*(1,141) = 18.9, *p* < 0.001, $\eta p2$ = .12, 95% CI [0.05, 1.00]), but this effect was qualified by an interaction between group and interview (*F*(2,141) = 3.71, *p* = 0.03, $\eta p2$ = 0.05, 95% CI [0.00, 1.00]) whereby older adults' target detail production was selectively lower for the G-SAI (*Mdn* = 0.46) than young adults (*Mdn* = 0.57, *U = 144, p* = 0.002, *rg* = -0.52, 95% CI [-0.20, -0.05]); there were no significant age difference for the AI and P-SAI (all *p-values* > 0.05; see **Figure 2.1**), only a trend for older adults to include fewer target details (*Mdn* = 0.76) than younger adults (*Mdn* = 0.79) for the P-SAI that did not survive correction (*U* = 202*, p* = 0.05, *rg* = -0.52, 95% CI [-0.05, 0.001]). In sum, older adults modulated their retrieval output of personal episodic and semantic information according to instructions to a similar degree as younger adults, but they had more difficulty suppressing off-target content when prompted with general semantic cues. As seen below, examination of specific categories of details revealed more nuanced age group effects.

We next explored whether young and older adults retained their rank in the proportion of on-target content across interviews. The within-group rank order correlations between the AI and the P-SAI were significant for the young (τ = 0.30, *p* = 0.04) and older adults (τ = 0.32, *p* = 0.03), whereas the within-group correlations between the AI and the P-SAI with the G-SAI were not significant (all *p values* > 0.08). These results suggest moderate intra-individual consistency for both younger and older adults for the interviews evoking personal episodic or semantic content, but not general semantic content.

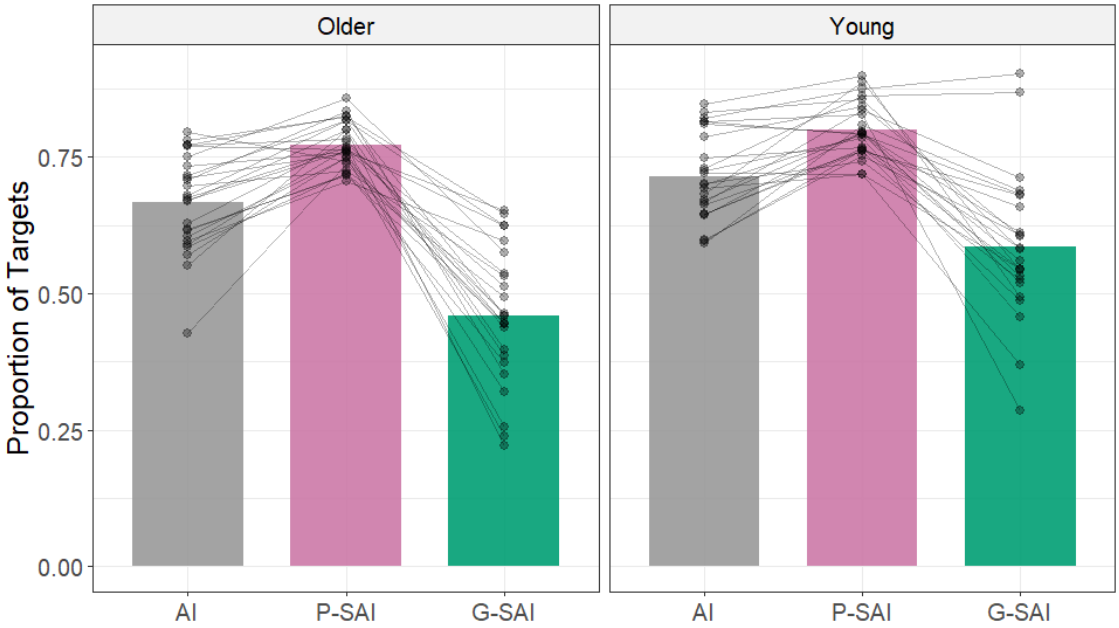

Figure 2. 1. Proportion of target recall in young and older adults. Individual lines and dot represent participants. Target details refer to the information that are directly probed by instructions: episodic details in the AI (Autobiographical Interview); personal semantic details (autobiographical facts, self-knowledge and repeated events) in the P-SAI (personal semantic interview); general semantic details in the G-SAI (general semantic interviews).

2.3.2. Age differences in details elaboration in each interview

Figure 2.2 and **Table 2.3** provide a finer-grain level of analysis concerning the categories of detail production across the three interviews. Episodic details were clearly modulated downward in the P-SAI and G-SAI relative to the standard AI. Indeed 20 young and 7 older participants in the P-SAI and 22 young and 20 older participants in the G-SAI generated no episodic details in response to these cues. In both forms of the SAI, production of semantic details broadly corresponded to the instructions, with elevated autobiographical facts, self-knowledge in the P-SAI, and elevated general semantic facts in the G-SAI.

2.3.2.1. Autobiographical Interview

There was a main effect of detail type (F(6,329) = 1593.7, p < 0.001, ηp2 = 0.97, 95% CI [0.96, 1.00]), and a significant detail type x group interaction (F(6,329) = 5.55, p < 0.001, ηp2 = 0.09, 95% CI [0.04, 1.00]), but no main effect of group (p > 0.98). In particular, older adults' narratives included a higher proportion of autobiographical facts than young adults (*Mdn* = 0.09 vs. 0.05 for young vs. older; *U = 456, p* = 0.01, *rg* = 0.52, 95% CI [0.01, 0.06]; see **Figure 2.2** and **Table 2.3**). Older adults also produced higher proportion of self-knowledge than young adults (SK, *Mdn* = 0.02 vs. 0.01; *U = 421, p* = 0.01, *rg* = 0.40, 95% CI [0.002, 0.02]) but a lower proportion of episodic details (*Mdn* = 0.66 vs. 0.72; *U = 196, p* = 0.04, *rg* = -0.35, 95% CI [-0.10, 0.003]), although these comparisons did not survive correction (p > 0.06; see **Figure 2.2** and **Table 2.3**). In sum, older adults off-task recall when describing past events mainly consist of autobiographical facts, as previously described (Renoult et al., 2020).

2.3.2.2. Personal Semantic Autobiographical Interview

The analysis of group differences in the proportion of details in the P-SAI revealed a main effect of detail type (F(6,329) = 565.13, p < 0.001, ηp2 = 0.91, 95% CI [0.90, 1.00]), and a detail by age group interaction (F(6,329) = 17.52, p < 0.001, ηp2 = 0.24, 95% CI [0.17, 1.00]), but no main effect of group (p > 0.98). Older adults produced a higher proportion of autobiographical facts (AF, *Mdn* = 0.46 vs. 0.37 for older vs. young; *U = 531, p* < 0.001, *rg* = 0.77, 95% CI [0.06, 0.12]), general semantic (GS, *Mdn* = 0.03 vs. 0.02; *U = 440, p* = 0.009, *rg* = .47, 95% CI [0.01, 0.03]), and episodic details (*Mdn* = .02 vs. 0.03;

U = 468, p < 0.001, *rg* = .56, 95% CI [0.01, 0.02]), but a lower proportion of self-knowledge details (SK, *Mdn* = 0.19 vs. 0.26; *U = 86, p* < 0.001, *rg* = -0.71, 95% CI [-0.10, -0.05]) and "other" details (*Mdn* = .08 vs. 0.10; *U = 127, p* = 0.02, *rg* = -0.42, 95% CI [-0.04, -0.01]; see **Figure 2.2** and **Table 2.3**), compared to young adults. In sum, older adults' preference towards autobiographical facts also emerged when describing personal life chapters, as shown by a higher proportion of autobiographical facts than young adults and a lower proportion of self-knowledge information. Older adults also produced a higher proportion of information not directly probed by instructions, particularly episodic details and general semantic knowledge.

2.3.2.3. General Semantic Autobiographical Interview

The analysis on the proportion of details within the G-SAI in young and older adults revealed a main effect of detail type (*F*(6,329) = 275.17, *p* < 0.001, ηp2 = 0.83, 95% CI [0.81, 1.00]), and significant interaction between age group and detail type (*F*(6,329) = 13.31, *p* < 0.001, ηp2 = 0.20, 95% CI [0.13, 1.00]), but no main effect of group (*p* > 0.98). In particular, older adults' narratives included a higher proportion of self-knowledge details than young adults (SK*, Mdn* = 0.20 vs. 0.11 for older vs. young; *U = 481, p* = 0.002, *rg* = 0.60, 95% CI [0.06, 0.18]) but also autobiographical facts (AF*, Mdn* = 0.09 vs. 0.03; *U = 436, p* = 0.01, *rg* = 0.45, 95% CI [0.01, 0.07]) as well as a lower proportion of general semantic (GS*, Mdn* = 0.46 vs. 0.58; *U = 144, p* = 0.006, *rg* = -0.52, 95% CI [-0.20, -0.05]) and other type of details (*Mdn* = 0.13 vs. 0.20; *U = 169, p* = 0.02, *rg* = -0.44, 95% CI [-0.11, -0.02]; see **Figure 2.2** and **Table 2.3**). In sum, even when participants are prompted with general semantic cues, older adults off-task recall is characterized by a preference towards autobiographical facts when compared to young adults. Older adults also include a higher proportion of self-knowledge information compared to young adults, revealing a general tendency in recalling personal semantic information even when the instructions target general semantic knowledge.

Table 2. 3. Proportion of details in young and older adults in the AI, P-SAI and G-SAI

	AI			P-SAI			G-SAI		
	OA	YA	*p*	OA	YA	*p*	OA	YA	*p*
Epi	**0.66**	**0.72**	**0.01***	0.02	0.003	0.001*	0.01	0.01	0.17
AF	0.09	0.05	<0.001*	**0.46**	**0.37**	**< 0.001***	0.09	0.03	0.007*
SK	0.02	0.01	0.07	**0.19**	**0.26**	**< 0.001***	0.24	0.11	< 0.001*
RE	0.02	0.01	0.29	**0.14**	**0.16**	**0.09**	0.01	0.002	0.10
GS	0.03	0.02	0.07	0.04	0.02	0.009*	**0.46**	**0.58**	**0.002***
Rep	0.09	0.09	0.94	0.08	0.09	0.45	0.05	0.04	0.12
Oth	0.09	0.11	0.59	0.08	0.10	0.02*	0.13	0.20	0.009*

Notes. Median values are reported for young and older adults together with the p-value corrected for multiple comparisons. The values in bold are the targets details in each interview. AI = Autobiographical Interview. P-SAI: Personal Semantic Interview. G-SAI: General Semantic Interview. OA = Older adults. YA = Young adults. AF = Autobiographical Facts. SK = Self-Knowledge. RE = Repeated Events. GS = General Semantic. Epi = Episodic. Rep = Repetitions. Oth = Other details. p = p value of the group difference. refers to significant group differences*

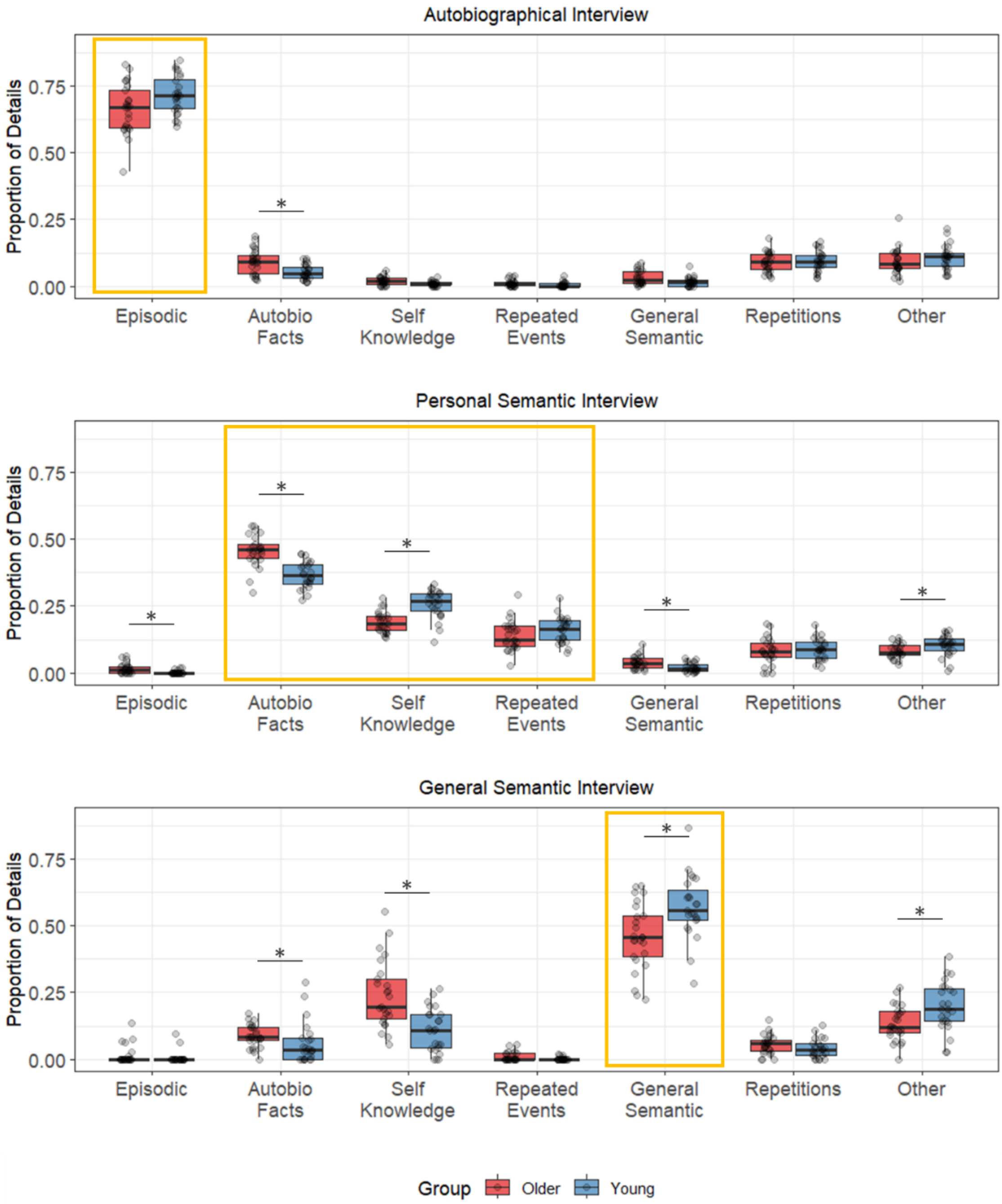

Figure 2. 2. Proportion of detail types in the cumulative recall of young and older adults, separate for the Autobiographical Interview, Personal Semantic Interview and General Semantic Interview. Dots represent individual subjects. The yellow box refers to the target details in each interview. Autobio Facts: Autobiographical Facts. * refers to significant group differences.

2.4. Discussion

The analysis of narrative recall is a fruitful technique for probing naturalistic memory, especially in aging and age-related conditions. People normally embed heterogeneous non-episodic content - such as personal or general semantic information - when asked to recall specific events from their past. Such incidental non-episodic recall is elevated in older adults. We controlled the nature of intentional-versus incidentally-cued narrative content by manipulating instructions of the Autobiographical Interview (AI; Levine et al., 2002) to elicit personal and general semantic content as opposed to episodic content, as is normally the case. There was evidence of age-related off-task content across all three interviews. Compared to younger adults, older adults' retrieval was biased towards personal semantic content (particularly autobiographical facts) regardless of task instructions, reflecting a shift in narrative style rather than merely an episodic memory deficit. Overall, participants modulated the content of their narratives depending on the instructions, such that episodic details were greatest on the standard AI, personal semantic details were greatest on the personal semantic section of the interview (P-SAI), and general semantic details were greatest on the general semantic section of the interview (G-SAI). We found a consistency in the proportion of target details between the AI and the P-SAI, reflecting a trait-level in the production of on-task details. Proportional scores on the G-SAI did not track with the other AI versions, possibly due to methodological factors (see below). Turning to the categories of details produced across sections of the interview, older adults produced a lower proportion of internal episodic details and a higher proportion of semantic details – particularly autobiographical facts – when remembering past events than younger adults, which is consistent with previous work on autobiographical memory recall in aging (Renoult et al., 2020; Simpson et al., 2023). For the semantic autobiographical interview (SAI), age differences in the personal semantic narratives (P-SAI) consisted of a higher proportion of autobiographical facts in older adults, but a lower proportion of self-knowledge details. In addition, older adults included a higher proportion of off-task recall, particularly general semantic and episodic details, compared to young participants. The elaboration of general semantic narratives (G-SAI) was characterized by older adults producing a lower proportion of general semantic and other types of details, but a higher proportion of self-knowledge than did young adults.

Age effects in autobiographical recall are often interpreted from the perspective of reduced episodic memory. For instance, a compensatory account, holds that older adults produce more non-episodic details to compensate for their reduced episodic detail recovery (e.g., Devitt et al., 2017). Such an account is not easily accommodated by our findings. Indeed, older adults produced a higher proportion of episodic details than younger adults under instructions to generate personal semantic narratives (although both groups suppressed episodic details relative to other details as shown by the fact that the majority of detail produced were personal semantics). Off-task recall was evident in the general semantic narratives of the G-SAI, where the proportion of target details was reduced in older adults when compared to young participants, but also in the P-SAI, where there were no group differences in the production of target details.

Other accounts focus on older adults' narrative styles and communicative goals rather than deficits, such as sharing an interesting story, including personal opinions and values (e.g., Hasher & Zacks, 1998; James et al., 1998). Moreover, older adults may be less motivated by social pressure, such as adjusting responses to the perceived needs of their interlocutor (Gold et al., 1988). Accordingly, some of the observed age differences may reflect a preference towards the elaboration of narratives with more “story asides” and off-topic speech (Bluck et al., 2016; Trunk & Abrams 2009), which varies in their content more than in young adults (Sheldon et al., 2023). What remains unclear and would deserve further study is to better characterize the respective roles of a difficulty in older adults to inhibit irrelevant information (Amer et al., 2022) and a deliberate choice to include additional details to tell a good story and give more context to the listener (Mair et al., 2023).

Additional support toward the proposal of different narrative style in aging comes when considering the finer-grained analyses of off-task detail categories. Autobiographical facts and self-knowledge information were not only preferred by both age groups to describe personal life chapters in the P-SAI, they also attracted the most off-task utterances in response to instructions to elaborate unique events (AI) and general knowledge (G-SAI) in older adults. Autobiographical facts have been conceptualized as knowledge about objective elements of our past, resembling a schematic autobiography, as well as knowledge of personal acquaintances and close-others (Grilli & Verfaellie, 2014; Renoult et al., 2012; Renoult et al., 2020). On the other hand, self-knowledge refers to a summary of personality traits and character, thus is a more subjective form of personal semantic memory (Renoult et al., 2012). These findings suggest that older adults’ off-task recall is not simply content excluded by instructions (i.e., episodic details when given semantic instructions). Rather, older adults are biased towards the production of personal semantic information that is both adaptive and meaningful to them (Grilli & Sheldon, 2022).

2.4.1. Limitations

Given the general preservation of semantic memory in aging (e.g., Allen et al., 2002; Spaniol et al., 2006), one might expect that, when asked to elaborate semantic knowledge in the G-SAI, the performance of older adults would not differ from that of young adults, especially with regard to the amount of target semantic details. Yet older adults included a lower proportion of general semantic knowledge in the G-SAI, together with a higher proportion of autobiographical facts and self-knowledge, compared to young adults. This may be attributable to the confinement the time period to the last year, an experimental design choice governed by the fact that younger adults were disadvantaged for the production of general semantic information during the remote period, which occurred during their childhood. It is also the case that – unlike the P-SAI and the AI – the G-SAI instructions did not explicitly prohibit personal semantic or episodic details. Given these less strict instructions, older adults may have focused on their personal opinions and beliefs while talking about general knowledge, as they were not explicitly instructed not to do so. This tendency of older adults in interpreting their semantic knowledge with personal opinions and beliefs, whereas young adults preferentially focused on the objective aspects of general semantic knowledge was observed in previous studies (Hasher & Zacks, 1988; James et al., 1998), and could be explained as a reinterpretation of general semantics from the lenses of the self (Rathbone et al., 2008). Of note, young and older adults did not differ in the amount of general semantic information as measured by detail counts (see the supplementary materials in the Appendix on page 165). Rather, older adults included more personal semantic information, particularly self-knowledge and autobiographical facts. Finally, the G-SAI was always administered after the AI and

P-SAI, both of which induced recall of personal information. Older adults may have had more difficulties in adapting to the new task demands that require them to describe general semantic knowledge (Strikwerda-Brown et al., 2021). Future studies may modify the instruction of the general semantic section and randomize the presentations of the different chapters (or conduct the different sections on different days) to overcome these limitations.

In this study, older adults consistently provided more details when recalling memories across all interviews. This resulted in older adults including more episodic details compared to younger participants in the AI (see the supplementary materials in the Appendix on page 164), which may appear in contrast with the well-established reduction in episodic details count in aging (Levine et al., 2002; Simpson et al., 2023). However, our pattern of results is not inconsistent with the age-related reduction in internal/episodic details when considering proportions of details (e.g., Levine et al., 2002; Miloyan et al., 2019), both in the cumulative and spontaneous recall phases (free recall + general probe; see the supplementary materials in the Appendix from page 169). Moreover, older adults produced an excess of autobiographical facts, replicating prior work (Renoult et al., 2020). Older adults may also have selectively benefited from the fact that this study was conducted online, at home. A recent paper (Badham et al., 2023) described a similar pattern of results and interpreted the absence of age difference in the amount of episodic details as related to the home environmental support, although the absence of age-related differences could be related to the different design of the task (written instead of verbal narratives; Pearson et al., 2023). Future work is needed to better understand the impact of the familiarity of the testing environment on participants' ability to recall episodic and semantic memories. Nonetheless, it is crucial to take into account the optimal estimate for the elaboration of autobiographical memory when analyzing participants' narratives. Indeed, utilizing proportions or ratio scores may provide a more accurate reflection of autobiographical recall, particularly when variations in the overall length of narratives are evident (Lockrow et al., 2023).

2.4.2. Conclusion

We investigated the effects of aging on focused episodic and semantic detail production in narrative recall by manipulating instructions with a new measure, the Semantic Autobiographical Interview (SAI). Older adults' off-task recall was not confined to the overproduction of semantic details when prompted with episodic cues; relative to younger adults, they produced more episodic details when prompted with personal semantic cues, and more personal semantic details when prompted with general semantic cues. Overall, older adults demonstrated a strong bias towards the production of autobiographical facts. These findings suggest that older adults' production of external details under standard AI instructions are not solely due to compensatory strategies or a general cognitive control deficit. This new version of the AI could be adapted to investigate different populations and time periods, including clinical samples with episodic and semantic impairments.

2.4.3. Acknowledgements

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Chapter 3

Age-related differences in autobiographical memory recall: impact of retrieval mode switching

3.1 Introduction

In our everyday life, we can flexibly retrieve autobiographical memories that vary in their content, from highly detailed and contextually specific unique events (episodic memories) to more abstract and decontextualised personal knowledge (like autobiographical facts; Barsalou, 1988; Conway & Pleydell-Pearce, 2000; Tulving, 2002). Research on age-related differences in autobiographical memory recall revealed that older adults' memories are typically more general and semanticised, even when instructed to recall unique events (Addis et al., 2008; Levine et al., 2002). This shift towards more semanticised memories has been related to changes in narratives style (Bluck et al., 1999; Bluck et al., 2016; see also Schacter et al., 2012), with older adults' memories including more story asides and non-target information (Amer et al., 2022; Bluck et al., 2016), intertwined with changes in cognitive control processes involved in retrieval (Craik & Bialystok, 2006; Holland et al., 2012; Ros et al., 2009; Spreng et al., 2018; Turner & Spreng, 2015).

Going above and beyond age differences, previous work revealed that the type of autobiographical memory recalled, unique episodes or more schematic and semanticised elements, depends on control processes and contextual factors, including the specific task demands (see Renoult et al., 2019). A common feature of the tasks used to study autobiographical memory is the block design, where participants are required to follow the same instruction for the entire duration of each block. Across different blocks, the instructions can be goal-directed, typically requiring participants to recall unique events (Levine et al., 2002; Williams & Broadbent, 1986), and sometimes more general events, such as memories of repeated events (Dalgleish et al., 2007; Ford et al., 2014). Alternatively, the instructions can be more open ended and participants are less guided on the type of memory to be recalled (Strikwerda-Brown et al., 2021). Age-related differences in memory performance particularly emerge in blocks with more goal-directed and specific instructions, and are less evident or absent with more general and open ended instructions (Ford et al., 2014; Strikwerda-Brown et al., 2021). Whereas young participants adjust retrieval content depending on the specific instructions, older adults' memories appear to be less modulated with task instructions, particularly when the task demands increase (Ford et al., 2014; Strikwerda-Brown et al., 2021). To investigate flexibility in recalling different types of memories depending on changes in instructions, Dritschel and colleagues (2014) developed the Alternate Instruction Autobiographical Memory Test (AMT-AI), combining the classic block design of autobiographical studies with a mixed-block design typical of task-switching paradigms. In the initial blocks of the AMT-AI, participants are asked to recall either specific episodic memories or categoric memories (repeated or extended events) in separate blocks (baseline block), then they are instructed to alternate between the recall of specific and categoric memories within the same block (alternating block). Memories are scored as correct or incorrect depending on their coherence with instructions (e.g., a recalled repeated event is considered correct if the instruction required the participant to recall a categoric memory).

Results from a sample of young adults revealed a reduced proportion of correct memories in the alternating instruction block, compared to the single-instruction block (Dritschel et al., 2014). This suggests that the higher task demands in the alternating block negatively impacted the ability of young adults to recall memories consistent with instructions. It has not yet been investigated whether the adoption of a similar task-switching paradigm might disproportionately influence autobiographical memory retrieval in older, as compared to young adults.

There is, however, a wide range of studies that explored how ageing impacts the ability to switch between different tasks. Previous studies revealed how age-related differences in switch costs (as indexed by decreased performance and/or increased reaction times) are modulated by the level of cognitive control demanded by the task's structure. In particular, increased switch costs in older adults have been found to vary with task uncertainty, such as cue ambiguity (Mayr, 2001), the unpredictability of the switch (Kray et al., 2002) and the absence of external cue to guide behaviour (Kray & Lindenberger, 2000). Switch costs in ageing, particularly increased response time, typically emerge when comparing the overall performance between a baseline block with only one instruction to follow, and a switching block which requires participants to maintain and adapt to varying instructions (e.g., Kray & Lindenberger, 2000). On the contrary, there is little evidence for age-related differences when looking at the switch costs at a trial level, thus when comparing the performance in switch trials and no-switch trials (or remain trials) within a block (Kray et al., 2002; Meiran et al., 2001; Mayr & Kliegl, 2000). Although cognitive ageing research has investigated age-related differences in task switching, little is known about the switching costs associated with autobiographical memory retrieval in ageing.

3.3.1. Current study

In this study, we used a modified version of the AMT-AI (Dritschel et al., 2014) to investigate the flexible retrieval of specific (unique events from one's past) and categoric memories (memory for an event that happened multiple times). Participants were initially instructed to recall specific and categoric memories sequentially (baseline block). In the following switching block, instructions to recall specific or categorical memories changed every second or third trial, instead of alternating on each trial (as in Dritschel et al., 2014), making the switch unpredictable for participants. We defined *switch trials* as those preceded by a trial with a different instruction, while *remain trials* followed a trial with the same retrieval instructions. We evaluated autobiographical memory recall by considering each memory as a whole (e.g., Dritschel et al., 2014; Piolino et al., 2006) and by deconstructing each narrative into details (e.g., Levine et al., 2002; Renoult et al., 2020; Strikwerda-Brown et al., 2019). Scoring each memory as a whole allowed for computing the percentage of recalled memories consistent with a given instruction (e.g., the proportion of repeated events recalled under categoric instructions). The analysis of the details produced within memories, on the other hand, provided a more detailed consideration of participants' ability to re-experience and elaborate each event (Levine et al., 2002). As these measurements, although similar, are not equally sensitive to ageing (Mair et al., 2021), we expected a different impact of task switching on our measures of interest, overall consistency with instructions and detail production. In particular, given that ageing is characterised by increased switching costs (for a meta-analysis, see

Wasylyshyn et al., 2011), we expected that switching between episodic and semantic retrieval modes would affect the performance of older adults, manifested as a lower proportion of memories recalled coherent with instructions, mainly when comparing baseline and switching blocks, but less so when comparing switch and remain trials.

When considering memory elaboration, given the general semanticisation of memories in ageing (Grilli & Sheldon, 2022; Levine et al., 2002; Spreng et al., 2018) and older adults' reduced ability to modulate their recollection with task instructions (Ford et al., 2014; Strikwerda-Brown et al., 2021), we hypothesized that details production would be less affected than overall coherence by the switch of instructions. More specifically, we expected to replicate the age-related differences in episodic autobiographical recall, characterised by fewer episodic details and more semantic information, but also a similar pattern of results for the elaboration of categoric memories. Repeated events have been conceptualised as the form of personal semantic memory most similar to episodic memory, which typically includes contextual and rich perceptual information (Conway & Pleydell-Pearce, 2000; Renoult et al., 2012; Rubin et al., 2003). Given this similarity with episodic memories, we expected older adults to include less contextually specific details and more semantic information when asked to recall repeated events.

3.2. Methods

3.2.1. Participants

35 older adults and 35 younger participants were recruited for the study. Young adults were undergraduate psychology students from the University of East Anglia recruited through the SONA online system and awarded with course credits. Older adults were

recruited through a local cohort and received an online voucher as a compensation for their participation (worth £12 per hour). Participants were English native speakers and screened for psychiatric, medical and neurological conditions that might impact normal brain functionality. Older adults were also screened for global cognitive impairments using the Addenbrooke's Cognitive Examination III (ACE-III, cut-off was 88, following Mioshi et al., 2006) and one older adult was excluded as they scored under the cut-off. Four additional older adults were excluded due to difficulty in following task instructions (see the Material section for more details). Two young adults were excluded due to difficulty in following task instructions, while four others were excluded due to poor quality of the recorded memories, which could not be transcribed. The analysed sample consisted of 30 older adults (25 Female and 5 Male) and 29 younger adults (26 Female and 3 Male). The final sample size was similar to that used in previous studies using a similar design (e.g., Ford et al., 2014). Young and older adults did not differ on our measures of executive functions (digit span backwards, the trail making test A and B; See **Table 3.1** for demographic information and neuropsychological results), nor in education level. All participants completed the Patient Health Questionnaire (PHQ9; Kroenke et al., 2001), and the Generalized Anxiety Disorder Assessment (GAD7; Spitzer et al., 2006) to control for potential group differences that could explain our results (see **Table 3.1**). The study was approved by the Research Ethics Committee of the School of Psychology of the University of East Anglia and all participants provided informed consent.

Table 3. 1. Participants demographic and neuropsychological assessment

	Older		Young	
	M	SD	M	SD
Age in years	70.13 (range 60 -79)	6.44	21.43* (range 18-31)	3.59
Education in years	15.89	1.90	14.79	1.52
ACE-III	95.79	2.58	-	-
Fluency	6.50	0.48	-	-
Composite Score	0.74	1.23	-	-
PHQ-9	2.00	2.19	3.17	3.44
GAD-7	0.89	1.64	2.76*	3.01
Trail making B-A time	14.1	13.9	8.88	13.4
Digit span backwards	6.29	1.49	5.74	1.55

Note. PHQ9 = Patient Health Questionnaire; GAD7 = Generalized Anxiety Disorder Assessment; PSQI = Pittsburgh Sleep Quality Index; Composite Score: averaged z-scores of the backward Digit Span and the Verbal Fluency from the ACE-III as in (Glisky, Polster, & Routhieaux, 1995)).
** The difference between groups are significant ($p < .05$).*

3.2.2. Stimuli

Twenty-one cue words were selected from the database of (Clark & Paivio, 2004). The words selected were neutral in emotional valence (M = 3.37, SD = 1.12) and high in concreteness (M = 6.56, SD = 0.69), imageability (M = 6.38, SD = 0.56) and Thorndike-Lorge frequency (M = 1.91, SD = 0.15) in order to increase the likelihood of an event recall. The cue words were counterbalanced across conditions and presentation order was randomized across participants. For the list of words used in the task refer to Table S.5 of the supplementary materials in the Appendix on page 176.

3.2.3. Material

Our autobiographical memory switching task was designed using Gorilla experiment builder (Anwyl-Irvine et al., 2020). In this task, participants were instructed to verbally recall specific and categoric events in response to cue words that appear on the screen. Instructions for the recall of *specific memories* required participants to describe in as much details as possible a specific event that happened at a specific time and place from their past (e.g., *"I had a good time at Jane's party last month in London").* Instructions for the recall of *categoric memories* required participants to describe memories of repeated events that happened in a similar way multiple times in their past in as much details as possible (e.g., *"I always enjoy spending time at the beach and looking at the sea").* The task was composed of two blocks: a baseline block and a switching block. In the *baseline block*, instructions required participants to first recall specific memories, and then categoric memories (or vice versa, the order was counterbalanced across participants). Participants were also given a detailed description and examples of specific and categoric memories, prior to the first recall. Participants were excluded from the analysis if they failed to recall all three practice categoric and/or all three practice episodic memories (4 older adults and 3 younger adults were excluded due to poor performance during this training block; see participants section). In the *switching block*, participants were instructed to recall specific or categoric memories depending on the instructions that appeared on the screen. Every two or three trials, the retrieval instructions changed. We defined each trial as *switch* if they were preceded by a trial with different instructions, or as *repeat,* if they were preceded by a trial with the same instructions. Participants recalled a total of 6 trials in the baseline block (3 specific and 3 categoric) and 14 trials in the switching block (3 switch episodic, 3 switch categoric, 4 repeat categoric and 4 repeat episodic trials). The type of memory retrieved in the first trial of this block, specific or categoric, was counterbalanced across participants. On each trial, participants were given up to one minute to search for a memory (memory construction phase). Once they had a memory in mind, they were instructed to press the recording button on the screen and then had up to two minutes to verbally describe the memory (memory elaboration phase). Once the elaboration phase was completed, they were asked to press the "stop recording" button on the screen. After verbally describing the memory, participants also completed a few subjective ratings: how detailed was the memory recalled (vividness; from 1 "poorly detailed" to 5 "highly detailed"), how emotional was recalling the memory for them (emotion; from 1 "not emotional at all" to 5 "intense emotional experience"), how was the perspective during retrieval (perspective; from 1 "seeing the event from your own eyes" to 5 "seeing the event from the perspective of an observer") and to locate the memory in time (time; "within last year", "less than 5 years ago", "between 5 to 10 years ago", "more than 10 years ago" and "across my life" only for categoric memories). Participants had 5 seconds to complete each subjective rating (see **Figure 3.1** for a graphic description of the trial and task structure). The subjective ratings were included to conduct an exploratory analysis of possible differences in the subjecting recall of specific and categoric memories, also comparing young and older adults.

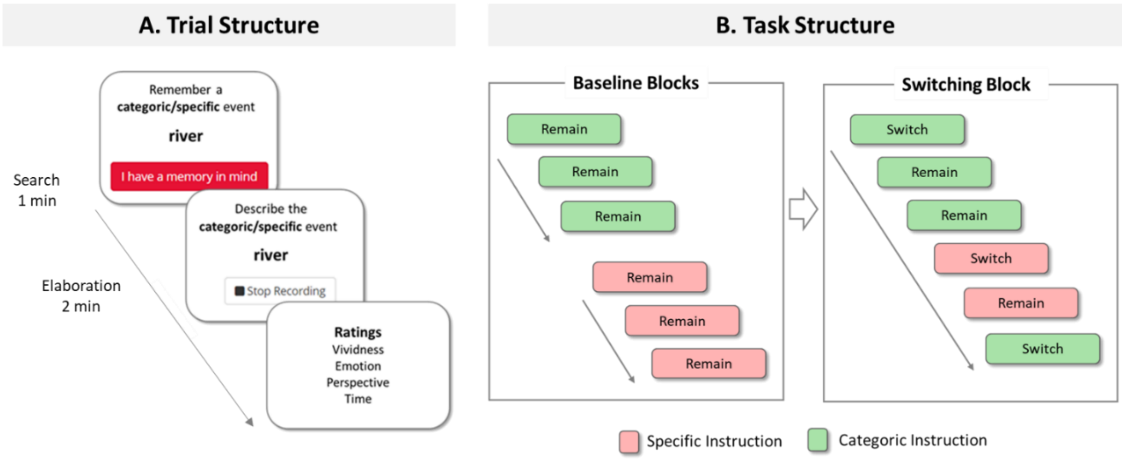

Figure 3. 1. Schematic description of the Retrieval Switching Task. Schematic description of the Retrieval Switching Task. (A) Participants were shown a cue word and instructed to recall either a specific or a categoric event and to press a button when they had a memory in mind. They had up to 1 minute to search for a memory. They were then asked to verbally describe the memory in as much details as they could for up to 2 minutes. Finally, they were asked to subjectively rate the vividness, emotion, perspective and time location of the recalled memory. (B) Instructions changed every 2 or 3 trials. The trials when the instructions changed are labelled as "switch trials" while the trials when the instruction were coherent with the previous trial are considered as "remain trials".

3.2.4. Procedure

Participants completed the experiment online. Young adults completed the autobiographical memory switching task and the neuropsychological tests in the same online session (duration was about 1 hour). Older adults completed the neuropsychological assessment in a first session during a video call on Microsoft Teams (duration was about 45 minutes), then they completed the autobiographical memory switching task on a separate online session to avoid subjecting them to long online testing sessions and thus to reduce fatigue (duration was about 30 minutes).

3.2.5. Scoring

Memories were scored for their consistency with instructions and for details production (count of different types of details produced). Consistency with instructions was determined following the AMT scoring (Williams & Broadbent, 1986). Each memory was categorized as one of the following: (1) *Specific*: episodic memory, unique event that lasted less than a day; (2) *Categoric*: repeated event, events that happened multiple time in the past in a similar way; (3) *Extended event*: event that lasted longer than a day; (4) *Semantic associate*: not an event, but personal or general semantic information (e.g., personal facts or self-knowledge). (5) *Omission*: no memory has been recalled. After this categorization, memories were considered consistent if the content of the narrative was coherent with the instruction (e.g., the memory recalled was of a unique event when the instructions asked to recall a specific memory, or the memory was of a repeated events when the instruction asked to recall a categoric memory). Overall consistency with instructions was then computed as the percentage of memories coherent with the instructions.

For details production scoring, each memory was segmented into details, each classified following an adaptation of the scoring scheme for the Autobiographical Interview (AI; Levine et al., 2002; see also Renoult et al., 2020 for the classification of semantic details). Each detail was scored as one of the following: (1) *Episodic*: detail about the unfolding of the event (including perceptual, spatial-temporal and emotional information); (2) *Repeated Event*: detail about a repeated event, including perceptual, spatial-temporal and emotional information; (3) *Semantic*: general and personal semantic information (including autobiographical facts and self-knowledge information); (4)

Other: repetition and metacognitive statement. Examples of participants' narratives can be found as supplementary material in the Appendix on pages 177 and 178. Details were then automatically counted and summed for each memory. To correct for difference in length of protocols across participants, we focused the analysis on the proportion-on-total details.

To assess reliability, a member of our lab (A.B.) blind to the age group and the specific study hypotheses, scored memories of 8 participants (4 randomly selected from the pool of older adults and 4 from the pool of young adults) for a total of 160 memory trials. The inter-rater reliability, calculated with the Intraclass correlation coefficient (ICC; two-way, random effects model), revealed very good to excellent scores for memory categorization (specific memories = 0.86; categoric memories = 0.93) and for the scoring of each detail type (episodic details = 0.81; repeated event details = 0.81; semantic details = 0.90; other details = 0.84).

3.2.6. Statistical analysis

Data were analysed using the R Statistical language (version 4.2.1; R Core Team, 2022). Before analysing detail counts, we applied to all memories a winsorization procedure to rescale detail counts exceeded +/- 2.5 SD from the mean to be 2.5 SD from the mean to control for a positive skewness of detail counts that is typical of autobiographical narratives (see McKinnon et al., 2008; McKinnon et al., 2015). To address the non-normal distribution of the data and variance among age groups, we conducted mixed ANOVAs using permutation tests. Given that a standard nonparametric test for a mixed design is not available, we randomly permuted the proportions of details between young and older adult participants, similar to previous studies (Grilli & Verfaellie, 2016; Konkel et al., 2008). We then recalculated the F-statistics for the permuted data set, repeating this process 10000 times to create a non-parametric distribution of F values for main effects and interactions. We considered main effects and interactions in the original data as significant if the newly calculated F value ranked in the top 5% of the distribution for that specific effect (following Grilli & Verfaellie, 2016; Konkel et al., 2008). For all pairwise comparisons, we employed the Mann-Whitney U test and corrected for false discovery rate of multiple comparisons (Benjamini & Hochberg, 1995).

We investigated the effect of switching on recall consistency with instructions, both at a block and trial level. The analysis conducted were the same both when comparing blocks and trials. The results of the comparison between baseline and switching block are presented in the main text, the analysis comparing switch and remain trials are presented as supplementary materials in the Appendix from page 179. We first ran an ANOVA with block (2; baseline and switching), group (2; young and older adults) and retrieval instruction (2; specific and categoric) as factors.

We tested group differences on details production both at a block and at a trial level. We first ran a mixed ANOVA on the proportions of details with block (2; block and switching), detail type (4; episodic, repeated event, semantic and other) and retrieval instruction (2; categoric and specific) as within-subjects factors, while group (2; older and young) as between factor.

Finally, subjective ratings of vividness, perspective, emotion and temporal location were analysed at a block and at a trial level. Subjective ratings were averaged across memories recalled within the same trial type. We ran ANOVAs with block (2;

baseline vs switching), retrieval instruction (2; categoric and specific) as within-subjects factors, and with age group (2; young and older adults) as a between-subjects factor. Analysis of temporal ratings followed the same structure but separately for specific and categoric instructions, as the ratings were different for specific (4; last year, within five years, from 5 to 10 years ago, and more than 10 years ago) and categoric memories (5; last year, within five years, from 5 to 10 years ago, more than 10 years ago and across the life course).

3.3. Results

3.3.1. Overall retrieval performance

The processed data and codes that support the findings of this study are available on the Open Science Framework project page, at https://osf.io/bgcw3/. The raw autobiographical memory narratives are not publicly available due to the highly personal content of autobiographical memories.

Table 3.2 reports the descriptive values of the types of memories (specific, categoric, semantic associates or extended events) that participants recalled in response to specific and categoric instructions, separate for the baseline block and the switching block. Overall, participants were able to follow instructions, as participants tended to recall specific events under specific instructions and categoric memories under categoric instructions, although older adults presented more difficulties in reporting categoric memories, particularly in the switching block.

Older and young adults took a similar time to select a memory (M = 17.27 vs 14.19 seconds, SD = 14.28 vs 14.26, p = 0.28), however older adults elaborated memories for a longer time than young adults (M = 45.33 vs 26.62 seconds, SD = 28.19 vs 20.17, $t(27.7)$ = 2.53, p = 0.02, d = 0.57, 95% CI [3321.37, 31851.88], however, we did not control for speech rate). To address this difference in length of protocols, in the following analyses we focused on the proportions of details recalled instead of details count.

Table 3. 2. Mean values (standard deviation) of proportions of memories recalled in the baseline and switching blocks, separate for specific and categoric instructions.

	Baseline block				**Switching block**			
	Specific		**Categoric**		**Specific**		**Categoric**	
	OA	**YA**	**OA**	**YA**	**OA**	**YA**	**OA**	**YA**
Specific	**0.83 (0.23)**	**0.74 (0.23)**	0.03 (0.10)	0.02 (0.09)	**0.76 (0.21)**	**0.86 (0.15)**	0.04 (0.09)	0.02 (0.07)
Extended Event	0.06 (0.15)	0.10 (0.18)	0 (0)	0.01 (0.06)	0.09 (0.11)	0.02 (0.04)	0.003 (0.01)	0 (0)
Categoric	0.03 (0.10)	0.09 (0.18)	**0.69 (0.26)**	**0.85 (0.23)**	0.01 (0.04)	0.02 (0.05)	**0.53 (0.33)**	**0.73 (0.29)**
Semantic Associate	0.10 (0.20)	0.07 (0.14)	0.25 (0.26)	0.10 (0.20)	0.08 (0.08)	0.03 (0.05)	0.22 (0.16)	0.12 (0.13)
Omissions	0.06 (0.13)	0.01 (0.06)	0.05 (0.13)	0.03 (0.10)	0.02 (0.04)	0.01 (0.03)	0.01 (0.03)	0.02 (0.05)

Note. Values in bold refers to the proportions of memories recalled coherent with given instructions (e.g., recall a categoric event under categoric instructions).

3.3.2. Impact of switch costs on recall consistency with instructions

We analysed the overall performance in the baseline block, where participants first recalled specific then categoric memories (or vice versa), and in the switching block, where participants switched between the recall of specific and categoric memories. In particular, we considered whether the proportion of memories recalled consistent with instructions decreased in switching conditions, in comparison to the baseline block. The ANOVA on the proportion of memories recalled revealed a main effect of group ($F(1,228) = 8.95$, $p < 0.001$), with older adults recalling overall a lower proportion of memories coherent with instructions (*Median* = 0.72) than young adults (*Mdn* = 81), a main effect of retrieval instruction ($F(1,228) = 5.46$, $p = 0.01$), with participants recalling a higher proportion of memories coherent with specific instructions (*Mdn* = 0.80) than categoric instructions (*Mdn* = 0.73), a significant interaction between group and retrieval instruction ($F(1,228) = 7.21$, $p = 0.003$), and a significant interaction between group and block ($F(1,228) = 2.73$, $p = 0.03$), while the main effect of block and the other interactions didn't reach a significant level (all *p-values* > 0.29). Post-hoc comparisons on the group x retrieval instruction interaction revealed that older adults showed a lower proportion of memories coherent with categoric instructions than young adults (*Mdn* = 0.64 vs. 0.82, $U = 1092$, $p < 0.001$, 95% CI [-0.33, -0.004]) but not with episodic instructions (*Mdn* = 0.79 vs. 0.80, p = 0.90). Post-hoc comparisons on the group x block interaction also revealed that older adults showed a lower proportion of memories coherent with instructions in the switching block than young adults (*Mdn* = 0.68 vs. 0.82, $U = 1161$, $p = 0.002$, 95% CI [-0.21, -0.03]) but not in the baseline block (*Mdn* = 0.76 vs. 0.80, p = 0.39; see **Figure 3.2**). In summary, consistently with our hypothesis, older adults showed a lower performance in the switching block than young adults. Moreover, older adults had more difficulties in recalling categoric, but not specific memories, when compared to young adults.

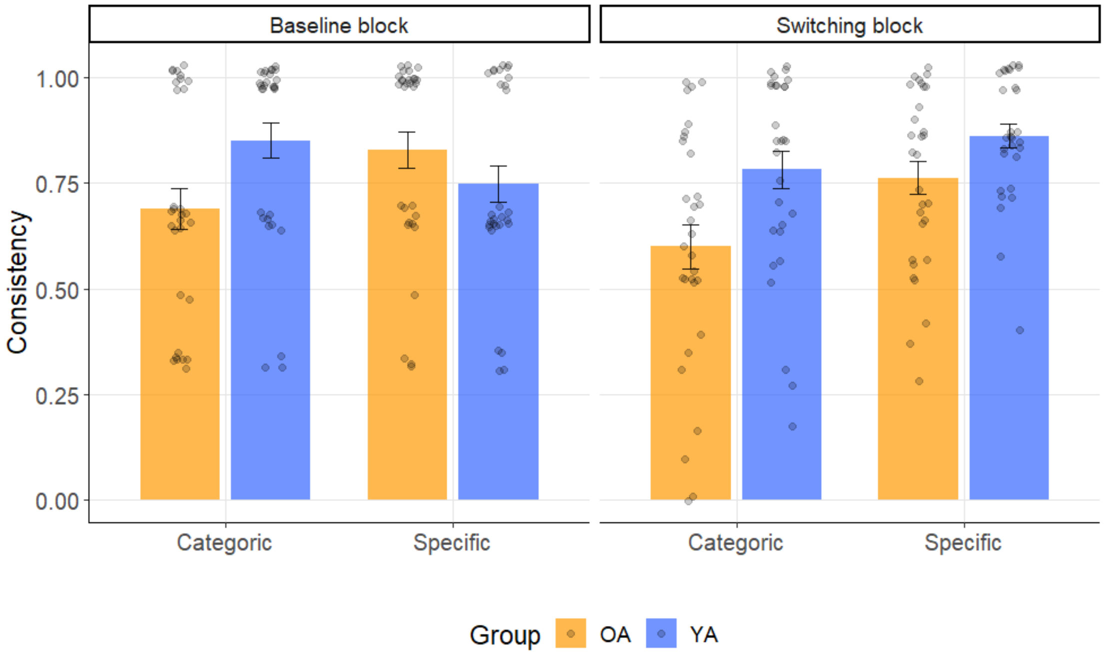

Figure 3. 2. Retrieval consistency with instructions in the baseline and switching blocks in young and older adults. The plot represents the proportion of memories recalled that were coherent with instructions in the baseline and switching blocks. The mean values are shown within the standard error bars. Points refer to individual data points. OA = Older adults. YA = Younger adults. Categoric = Categoric instructions. Specific = Specific instructions.

3.3.3. Memories recalled that were inconsistent with instructions

As an exploratory analysis, we considered the different types of memories that participants recalled when they failed to follow instructions, collapsed for baseline and switching blocks. We ran ANOVAs separate for categoric and specific errors with group (2; young and older), and memory type (4; extended, categoric, semantic associate and omission) as factors. The ANOVA on memories recalled under specific instructions revealed a main effect of memory type ($F(1,337) = 8.57$, $p = 0.004$, $\eta p2 = 0.02$, 95% CI [-0.003, -0.002]) but no main effect of group not interaction between these factors (all *p-values* > 0.07). When participants recalled memories not consistent with the specific instructions, they tended to recall more extended events than categoric memories (*Mdn* = 0.18 vs. 0.11, *U* = 1312*, p* = 0.01, 95% CI [-0.003, -0.002]), as well as more semantic associates than categoric memories (*Mdn* = 0.17 vs. 0.11, *U* = 1350*, p* = 0.03, 95% CI [-0.008, -0.002]). The ANOVA on memories recalled under categoric instructions revealed a main effect of group ($F(1,224) = 4.77$, $p = 0.03$, ηp2 = 0.02, 95% CI [0.0, 1.00]), with older adults making more errors than young adults (*Mdn* = 0.15 vs. 0.10), and a main effect of memory type ($F(3,224) = 56.20$, $p < 0.001$, ηp2 = 0.43, 95% CI [0.35, 1.00]), but no significant interaction ($p > 0.06$). When participants failed to recall categoric memories, they tended to recall more semantic associates than specific memories (*Mdn* = 0.42 vs. 0.08, *U* = 596, $p < 0.001$, 95% CI [-0.50, -0.33]), and more semantic associates than extended events (*Mdn* = 0.42 vs. 0.02, *U* = 400*, p* < 0.001, 95% CI [-0.33, -0.30]). In summary, when participants struggled to recall specific memories, they often recalled extended events and semantic associates as alternatives. When failing to retrieve categorical memories, participants most often produced semantic associates.

3.3.4. Impact of switch costs on the proportion of details produced according to instructions

We investigated the effect of switching between different retrieval modes on details production by comparing the performance during the baseline and switching blocks. The ANOVA revealed a main effect of detail ($F(1,912) = 245.87$, $p < .001$, ηp2 = 0.45, 95% CI [0.41, 1.00]), a significant detail x group interaction ($F(1,912) = 45.53$, $p < .001$, ηp2 = 0.13, 95% CI [0.10, 1.00]), a significant detail x retrieval instructions interaction ($F(1,912) = 799.69$, $p < .001$, ηp2 = 0.72, 95% CI [0.70, 1.00]) as well a significant group x detail x retrieval instructions interaction ($F(1,912) = 19.45$, $p < 0.001$, ηp2 = 0.06, 95%

CI [0.04, 1.00]). The main effects of block, group and retrieval instructions were not significant (*p-values* > 0.80), nor were the interactions between these factors (all *p-values* > 0.15; See **Figure 3.3**). Post-hoc comparisons on the detail x group interaction revealed that older adults recalled overall a higher proportion of semantic details than young adults (*Mdn* = 0.30 vs. 0.13 for older vs. young, *U* = 10698*, p* < 0.001, 95% CI [0.12, 0.19]) but a lower proportion of repeated event details than young adults (*Mdn* = 0.16 vs. 0.29 for older vs. young, *U* = 5802*, p* = 0.02, 95% CI [-0.15, -0.003]). Post-hoc comparisons on the detail x retrieval instructions interaction revealed that participants recalled memories under specific instructions with more episodic details than under categoric instructions (*Mdn* = 0.75 vs. 0 for specific vs. categoric, *U = 142, p* < 0.001, 95% CI [-0.74, -0.66]), revealing how participants were able to follow instructions. Moreover, participants recalled memories under categoric instructions with more repeated event details than under specific instructions (*Mdn* = 0.57 vs. 0 for categoric vs. specific, *U* = 13744*, p* < 0.001, 95% CI [0.49, 0.57]), but also with more semantic details (*Mdn* = 0.30 vs. 0.17 for categoric vs. specific, *U* = 9902*, p* < 0.001, 95% CI [0.01, 0.18]), revealing how participants were able to follow instructions but also tended to include more semantic information when the memory to be recalled was more general.

Given that participants elaborated upon specific and categoric memories differentially, we investigated the group x detail x retrieval instructions interaction by running ANOVAs on detail production separate for categoric and specific instructions trials. The ANOVA on the details recalled probed by specific instructions revealed a main effect of detail (*F*(1,228) = 923.39, *p* < .001, ηp2 = 0.92, 95% CI [0.91, 1.00]), a significant detail x group interaction (*F*(3,228) = 18.11, *p* < .001, ηp2 = 0.19, 95% CI

[0.12, 1.00]), while the main effect of group was not significant (*p* = 0.89). Post-hoc comparisons revealed that older adults recalled a lower proportion of episodic details than young adults (*Mdn* = 0.69 vs. 0.78 for older vs. young, *U* = 1234, *p* = 0.002, 95% CI [-0.17, -0.04]) but a higher proportion of semantic details (*Mdn* = 0.22 vs. 0.08 for older vs. young, *U* = 732, *p* < 0.001, 95% CI [0.08, 0.16]), while no difference was found in the proportion of repeated events and "other" types of details (all *p-values* > 0.62; See **Figure 3.3**). The ANOVA on the details recalled probed by categoric instructions revealed a main effect of detail (*F*(1,228) = 208.04, *p* < .001, ηp2 = 0.73, 95% CI [0.69, 1.00]), a significant detail x group interaction (*F*(3,228) = 29.23, *p* < .001, ηp2 = 0.28, 95% CI [0.20, 1.00]), while the main effect of group was not significant (*p* = 0.90). Post-hoc comparisons revealed that older adults recalled a lower proportion of target repeated event details than young adults (*Mdn* = 0.46 vs. 0.71 for older vs. young, *U* = 166, *p* < 0.001, 95% CI [-0.34, -0.14]) but a higher proportion of semantic details (*Mdn* = 0.42 vs. 0.20 for older vs. young, *U* = 762, *p* < 0.001, 95% CI [0.15, 0.29]), while no difference was found in the proportion of episodic and "other" types of details (*p* > 0.05; See **Figure 3.3**). In summary, consistent with our hypothesis, we observed switch costs on details productions. Moreover, age-related difference were found and were characterised by older adults producing a higher proportion of semantic details than young adults, together with a lower proportion of details coherent with instructions (episodic details under specific instructions and repeated events under categoric instructions).

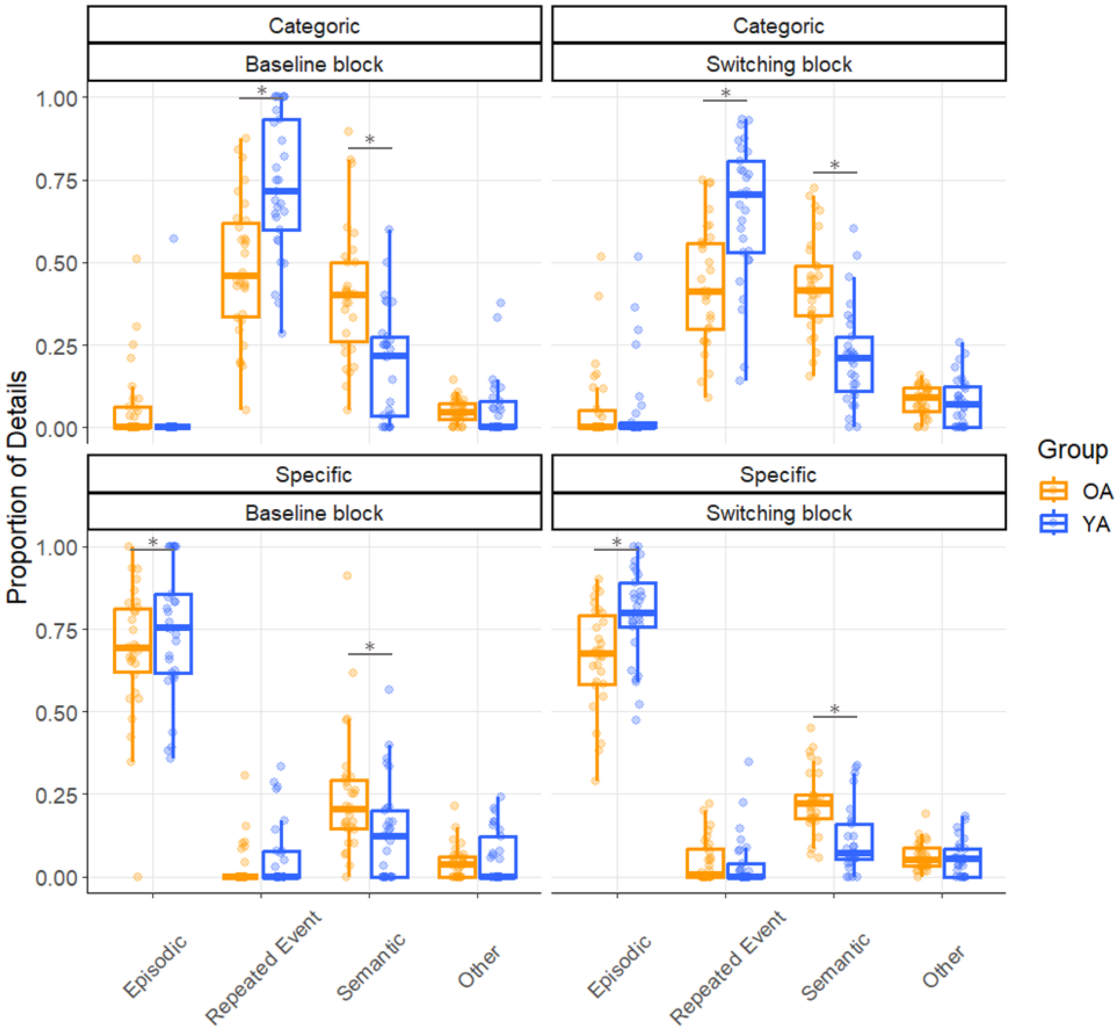

Figure 3. 3. Box plot for proportion of details in young and older adults, separate for specific (episodic) and categoric (repeated event) memories. Proportion of details refers to the proportion of details type on total details. Under categoric instructions, olde adults included a lower proportion of repeated events details but a higher proportion of semantic details than young participants. Under specific instructions, older adults memories' had a lower proportion of episodic details but a higher proportion of semantic information than young adults. OA = Older adults. YA = Young adults. Standard error bars are shown in the plot. * refers to significant differences between YA and OA.

3.3.5. Subjective ratings

We then analysed group differences in the subjective ratings of vividness, visual perspective, emotion and time of the memories produced in episodic and categoric recall.

Vividness Ratings. The mixed ANOVA on vividness ratings revealed a main effect of retrieval instructions ($F(1,228) = 27.91$, $p < .001$, $\eta p2 = 0.11$, 95% CI [0.05, 1.00]), a main effect of group ($F(1,228) = 47.85$, $p < .001$, $\eta p2 = 0.17$, 95% CI [0.11, 1.00]), and an interaction between group and retrieval instructions ($F(1,228) = 11.01$, $p = 0.001$, $\eta p2 = 0.05$, 95% CI [0.01, 1.00]), but no main effect of block, nor any additional interactions (all *p-values* > 0.23). Post-hoc comparisons showed that older adults' considered their memories as more vivid then young adults, both when considering narratives under specific instructions (*Mdn* = 3.94 vs 3.65, $U = 2206$, $p = 0.01$, 95% CI [0.03, 0.67]), and categoric instructions (*Mdn* = 3.67 vs 2.67, $U = 2857$, $p < 0.001$, 95% CI [0.67, 1.33]).

Perspective Ratings. The mixed ANOVA on perspective ratings did not reveal main effects of group, block, or retrieval instructions, nor any interactions between these factors (all *p-values* > 0.10).

Emotion Ratings. The ANOVA on emotion ratings revealed a main effect of retrieval instructions ($F(1,228) = 15.22$, $p < .001$, $\eta p2 = 0.06$, 95% CI [0.02, 1.00]), with memories retrieved under specific instructions judged as more emotional than those under categoric instructions (*Mdn* = 3.00 vs 2.65), and a main effect of group ($F(1,228) = 8.57$, $p = 0.004$, $\eta p2 = 0.04$, 95% CI [0.01, 1.00]), with older adults rating memories as more emotional than young adults (*Mdn* = 3.00 vs 2.65), but no main effect of block, nor any interaction with other factors (all *p-values* > 0.21).

Temporal Ratings. We then looked at the time of the specific and categoric events recalled, separate for categoric and specific retrieval instructions, in the baseline and switching blocks. The mixed ANOVA on the temporal subjective ratings revealed a main effect of time of the events($F(4,570) = 18.41$, $p < .001$, ηp2 = 0.11, 95% CI [0.07, 1.00]), a significant interaction between time and group ($F(4,228) = 14.09$, $p < 0.001$, ηp2 = 0.09, 95% CI [0.05, 1.00]), and a significant interaction between time of the events and block ($F(4,228) = 5.40$, $p < 0.001$, ηp2 = 0.04, 95% CI [0.01, 1.00]), while no main effect of group and block were found, nor any additional interactions between these factors (all *p-values* > 0.09). Follow-up analysis on the time of events x group interaction revealed that, under categoric instructions, older adults recalled more memories older than 10 years than young adults (*Mdn = 0.42 vs 0.13 for older vs young, U* = 2631*,* $p < 0.001$, 95% CI [0.14, 0.33]), but less memories from last year (*Mdn = 0.10 vs 0.29 for older vs young, U* = 1145*,* $p < 0.001$, 95% CI [-0.20, -0.001]) and the past 5 years (*Mdn = 0.09 vs 0.15 for older vs young, U* = 1384*,* $p = 0.03$, 95% CI [-0.04, -0.01]; See **Figure 3.4**). The mixed ANOVA on the temporal subjective ratings under specific instructions revealed a main effect of time of events ($F(4,570) = 16.95$, $p < .001$, ηp2 = 0.10, 95% CI [0.06, 1.00]), and a significant interaction between time of events and group ($F(4,228) = 55.09$, $p < 0.001$, ηp2 = 0.27, 95% CI [0.21, 1.00]), while no main effect of group and block were found, nor any additional interactions between these factors (all *p-values* > 0.71). Follow-up analyses on the time of events x group interaction revealed that, under categoric instructions, older adults recalled more memories older than 10 years than young adults

(*Mdn = 0.53 vs 0.07 for older vs young, U* = 3096*, p* < 0.001, 95% CI [0.34, 0.62]), but less memories from last year (*Mdn = 0.22 vs 0.46 for older vs young, U* = 1025*, p* < 0.001, 95% CI [-0.33, -0.12]) and the past 5 years (*Mdn = 0.14 vs 0.34 for older vs young, U =* 789*, p* < 0.001, 95% CI [-0.33, -0.14]; See **Figure 3.4**). In summary, while young adults preferred to recall recent memories (within the last 5 years and particular from the last year), older adults tended to recall more remote memories.

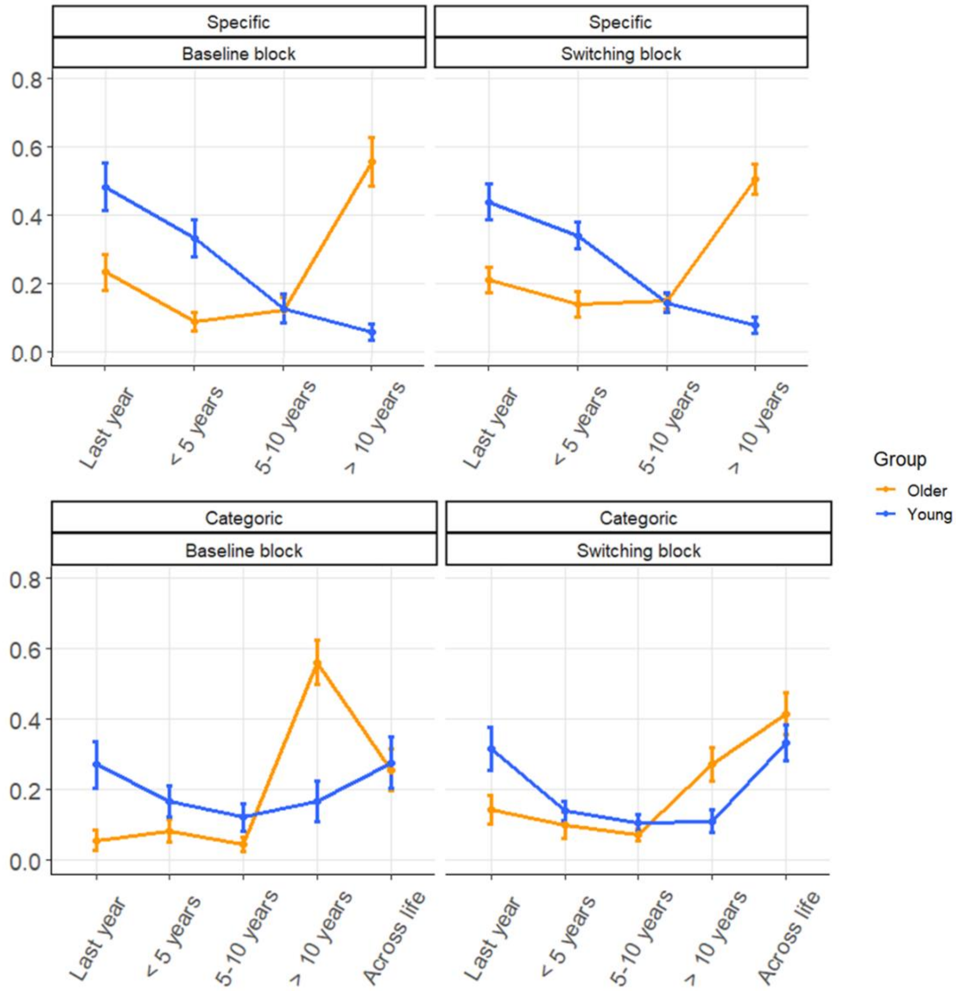

Figure 3. 4. Line plots for the temporal distribution of memories under specific and categoric instructions in young and older adults, separate for baseline and switching blocks. Y values represent mean frequencies of recalled memories. Error bars represent standard errors of the mean.

3.3.6. GAD and memory performance

Prior research showed that a state of anxiety could reduce autobiographical memory specificity (Hallford et al., 2019). As our group of young adults had higher anxiety scores than the older adults (see **Table 3.1**), we made sure that our results were due to the effect of age on memory, and not the effect of anxiety, and ran correlations between the amount of specific details in the episodic memories and the amount of repeated event details in the categoric memories with the GAD scores. None of the correlations was statistically significant (all *p-values* > 0.23). We also ran correlations between the GAD scores and the overall coherence with instructions of specific and categoric memories in switch and non-switch trials. As before, no correlations between performance and GAD score were significant (all *p-values* > 0.08).

3.4. Discussion

In the present study, we investigated age-related differences in switch costs during the recall of different types of autobiographical memories: *specific events*, memories of past unique episodes, and *categoric events*, memories of past experiences that happened multiple times in a similar way. In particular, we investigated the impact of switching on the ability to elaborate narratives of autobiographical events that are coherent with instructions, and on the production of different types of details within narratives. Switch costs only emerged when comparing the overall consistency with instructions at a block level (comparing baseline and switching block) but not a trial level (when comparing switch and remain trials in the switching block – see the supplementary materials in the Appendix from page 179). Moreover, we found age-related differences both when considering coherence with instructions and details production. The detailed findings are discussed below.

3.4.1. Reduced coherence with instructions as a switch cost in ageing

Our findings revealed that, overall, older adults presented more difficulties in recalling memories coherent with instructions than young adults. When considering effects of switch costs on memory performance, we found that older adults produced a lower proportion of memories coherent with instructions in the switching than in the baseline block. However, no difference emerged when looking at the switch costs at a trial level, comparing switch and remain trials. Moreover, older adults showed more difficulties under categoric than specific instructions at a block but not at a trial level. Finally, we observed that participants showed better performance when recalling specific than categoric memories.

In autobiographical memory research, previous studies have reported that older adults are less capable than young adults of modulating the content of retrieved memories according to task instructions (Ford et al., 2014; Strikwerda-Brown et al., 2021). In these experiments, participants were required to recall episodic or more general memories in separate blocks, under instructions that could vary in precision (goal-directed vs open-ended). Age differences were typically observed when task demands increased, therefore in blocks with more goal-directed instructions, particularly when older adults were asked to recall unique episodic memories (Ford et al., 2014; Strikwerda-Brown et al., 2021). In addition to manipulating which type of memory to recall with instructions, task demands can be manipulated by modifying the task structure, for example, by requiring participants to switch between different tasks (e.g., Wylie & Allport, 2000). Only a few studies investigated autobiographical memory recall adopting a task-switching design and, to our knowledge, only in young adults. In the previously described study from Dritschel and colleagues (2014), young adults had a reduced performance in the alternating block, as compared to the single instruction block. Switch costs at a trial level were described by Rathbone and Moulin (Rathbone & Moulin, 2014), who observed longer response times for recalling autobiographical memories in young adults, when switching from one type of self-image to another. Our study extends these previous findings to ageing by showing that, when manipulating processing demands using a task-switching design, older adults recall fewer memories consistent with instructions in the switching blocks as compared to young adults. Nonetheless, similarly to what has been observed in studies utilizing non-autobiographical tasks (e.g., Kray et al., 2002; Meiran et al., 2001; Mayr & Kliegl, 2000), differences in performance were not evident at a trial level, comparing switch and remain trials.

Although switching between different tasks requires the involvement of cognitive control processes (e.g., Monsell, 2003), we did not find age differences in our measures of executive functions. One possibility is that the older adult tested were high-functioning individuals that performed as young adults in standard measures of executive functions, thus, are not characterised by a clear decline in cognitive control (see Veríssimo et al., 2022 for similar findings). This would also explain why we did not observe age differences when specific or categoric memories were recalled in separate trials, although an overall reduction in performance was evident in older adults without considering the type of memory recalled nor the type of trial.

The reduced performance of older adults while recalling categoric memories is somehow unexpected, as we hypothesised more errors for specific than categoric memories. Older adults might have had more difficulties in restricting the recall of categoric memories to repeated events and included other types of personal semantics, particularly autobiographical facts (Renoult et al., 2020; Melega et al., 2023), which led to an overall reduction in performance. The tendency of older adults to retrieve more general autobiographical memories when instructed to recall specific events (e.g., Addis et al., 2008; Levine et al., 2002; Piolino et al., 2002), might therefore also extend to memories of repeated events.

3.4.2. Absence of switch costs when considering memory elaboration

Switching retrieval mode had a lesser effect on memory elaboration, as compared to overall coherence with instruction, as we found no differences in the proportion of details recalled at a block level (comparing baseline and switching block), nor at a trial level (comparing switch and remain trials in the switching block). These findings reveal that memory elaboration appears less influenced by the increased task demands associated with retrieval switching and more by the age-dependent shift from episodic to semantic retrieval. Support for this findings of memory elaboration being unaffected by retrieval switching, can be found in a recent study from Mair and colleagues (Mair et al., 2021), who showed how autobiographical memory specificity, the ability of recalling unique events when the instructions required one to do so, was associated with efficiency in executive abilities, whereas details production, the ability of describing the unfolding of the event, appears to be less dependent on such executive abilities.

Consistent with previous findings, older adults included a higher ratio of semantic details and a lower proportion of episodic details than young adults when describing unique events from their past (e.g., Addis et al., 2008; Levine et al., 2002). Interestingly, older adults also recalled categoric memories with a lower proportion of repeated events details and a higher proportion of semantic details than young adults. Categoric or repeated events are thought to emerge from the extraction of commonalities across a series of separate but similar events (Barsalou, 1988; Neisser, 1981; Rubin & Umanath, 2015). Although repeated events are more general and schematic than unique episodes, they also maintain perceptual and contextual information (Renoult et al., 2012; Rubin & Umanath, 2015). Given these high similarities with memories of unique events, it is not surprising that older adults recalled memories under categoric instructions with a lower proportion of contextually specific details and a higher ratio of general and semantic information than young adults. Our results fit well with the recent interpretation of a general preference to describe the gist and broader meaning of events in ageing (Grilli & Sheldon, 2022).

Older adults tended to recall remote episodic memories, while young adults preferred recalling recent memories. At a glance, this pattern of results is in line with the reminiscence bump, as the tendency of older adults to recall more events from adolescence and early adulthood than from more recent lifetime periods (Janssen et al., 2012; Koppel & Berntsen, 2015; Rubin & Wenzel, 1996). However, we cannot be sure whether older adults were recollecting memories from an equivalent time period as young adults, such as the reminiscence bump. The structure of the present task, as typical of studies using the Autobiographical Memory Test (AMT; Williams & Broadbent, 1986), lets participants select their most relevant memories without any constraints about the lifetime periods to target. In the current study, this task structure allowed us to obtain a similar proportion of recalled memories coherent with instructions across age groups at baseline, with only age impairments observed in the switch conditions. Future studies could manipulate the time of recall, instructing participants to recall events from a specific time (e.g., last year), to see if age-related differences emerge also in the baseline block when participants either recall specific or categoric memories.

Finally, results on vividness rating are in line with previous findings in literature, with older adults rating their memories as more vivid than young adults despite a reduction in the amount of specific details included in the narratives (Folville et al., 2021; Folville et al., 2020; St-Laurent et al., 2014). This discrepancy between the details produced and the intensity of their ratings has been related to age differences in how the details produced are used to judge the personal experience of remembering (Folville et al., 2022). Given the preference towards more gist-like and semanticised details production, one possibility is that older adults are focusing more on the broader context, relying more on semantic details when making their judgments. Future work is needed to explore this possibility.

3.4.3. Limitations and future directions

There are some limitations of the present study. First, to avoid long online testing sessions and fatigue, especially in older adults, we have only included three episodic and three categoric switch trials. The small number of switch trials might have impacted our analysis and results. Previous studies revealed that switching between episodic (e.g., old/new recognition memory) and semantic recall (e.g., animacy judgments) leads to longer response times and, to a lesser extent, reduced memory accuracy during episodic memory retrieval (Evans et al., 2015; Herron & Wilding, 2004; Mayr & Kliegl, 2000; Morcom & Rugg, 2002). Moreover, autobiographical memory studies revealed that increased task demands preferentially affect episodic memories retrieval (e.g., Dritschel et al., 2014; Ford et al., 2014) and, more generally, the most complex and effortful task (e.g., Vatansever et al., 2021). In our study we found a different pattern of results, as participants, particularly older adults, presented a lower performance for categoric (thus more semantic) than episodic instructions. Future studies could increase the number of switch trials to test whether there is a hierarchy of switching within task, in particular looking at which memory type is the most affected by switch in instructions.

Although switch costs usually refer to decreased performance and increased reaction times, we only focused on the effect of switching on memory elaboration, looking at the overall consistency with instructions and at the details included in the narratives. Given the online nature of the task, there was variability in the devices used by participants (e.g., touchscreen, touchpad or mouse), especially among older adults, which would have affected the reliability of response time measures. Future studies could better control the devices used by participants and include a measure of reaction time in the costs of switching between different types of autobiographical memories.

In our paradigm, participants were allowed to choose memories from any time period and were subsequently asked to determine the specific time when the memory occurred. To comprehensively explore the effects of switching during memory retrieval, future studies could specify predefined time periods from which participants are permitted to recall memories (as in Levine et al., 2002). Implementing such a restriction would facilitate a thorough performance comparison between young and older adults. Finally, older adults exhibited longer elaboration time than young adults. Future studies could include follow-up questions after free recall (as in Levine et al., 2002) aimed at eliciting details production from all participants to enhance comparability between the narratives of young and older adults.

3.4.4. Conclusion

In the present study, we investigated age differences in switch costs between the recall of episodic and semantic memories. Consistent with previous work on task-switching, we found a reduced ability in recalling memories coherent with instructions, when older adults recalled memories in the switching block but not in the baseline block, as compared to young adults. When considering memory elaboration, the impact of task-switching was more limited, and age-related differences in details production mainly consisted of increased semanticisation of memories of unique and repeated events. Together these results reveal that autobiographical memory retrieval in ageing is highly dependent on the specific task demands, intertwined with a general episodic-to-semantic shift and a preference towards gist-like events.

3.4.5. Acknowledgements

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Chapter 4

The semantic structure of events consistently influences memory performance over time in young and older adults

4.1 Introduction

Remembering the past often involves constructing narratives that connect various events and information about an experience (Bartlett et al., 1932). The importance of narratives in event comprehension emerged when researchers started to incorporate naturalistic stimuli into experimental paradigms, such as written stories and films, aiming to mirror memory retrieval processes as they would take place in real-life situations (Lee & Chen, 2020; Willems et al., 2020). This naturalistic approach has shed light on how memory recall is influenced by the perception of events structure within experiences (e.g., Baldassano et al., 2017; Chen et al., 2017). Notably, episodic memory is influenced by the semantic structure of a naturalistic experience. Indeed, events within narratives are better remembered when they exhibit more and stronger semantic connections to other events (Lee & Chen, 2022) and when they can be integrated into a coherent narrative (Cohn-Sheehy et al., 2021). The extent to which the influence of semantic structure on episodic memory is maintained over time and over multiple retrieval opportunities is unclear. Similarly how this influence may vary between young and older adults is not well understood.

Most of the studies investigating the impact of event structure on retrieval focused on immediate retrieval, leaving unanswered whether the same would occur after a delay. A recent study provided evidence that event segmentation, the ability to identify events within a continuous experience, affects memory not only directly after encoding (e.g., Sargent et al., 2013; Schwan et al., 2000; Zacks & Tversky, 2001) but also after a week or a month (Flores et al., 2017). Thus, temporal event structure has been found to have a consistent effect on recall immediately after encoding and after a period of consolidation, possibly by supporting the formation of stable memory representations.

When considering the content of the memories over time, research in young adults indicates that memories tend to transform from highly detailed to more general and gist-like in a process of "semanticisation" (Sekeres et al., 2018; Winocur & Moscovitch, 2011). Over a week, participant's narratives for naturalistic stimuli are characterised by a reduction in *peripheral* information, such as perceptual and contextual information (e.g., where the characters are standing in a room), but a retention of the *central* elements of the story, those pivotal for narrative comprehension (e.g., actions carried out by the characters that are necessary to understand the unfolding of the story; Sacripante et al., 2023; Sekeres et al., 2016; Sekeres et al., 2018). This reduction in peripheral information can however be compensated by actively recalling the story immediately after encoding. Indeed, rehearsing the content of the stories shortly after encoding appears to strengthen memory representations and to protect peripheral information from time-dependent decay (Bird et al., 2015; Sekeres et al., 2016). Studies in ageing revealed a similar benefit of repeated retrieval on the retention of narrative information (Rogalski et al., 2014) and on visual and verbal information (Jonker et al., 2018; Theppitak et al., 2014). However, it is still unclear whether older adults similarly benefit from repeated retrieval as young adults do, when using naturalistic and multisensory stimuli, like videos, widely used to investigate memory processes in young individuals.

Studies adopting narrative-like stimuli at encoding, such as prose and visual narratives, to investigate age-related differences in memory retrieval showed that when older adults recall stories, they retain the elements central, the *gist* of the events, as young adults do (Delarazan et al., 2023; Sacripante et al., 2019; Taler et al., 2021). However, older adults' narratives are characterized by a reduced production of peripheral information compared to those of young adults (Delarazan et al., 2023; Sacripante et al., 2019; St-Laurent et al., 2014; Taler et al., 2021). Older adults' tendency to rely more on general details when recalling stories emerges not only when recalling non-personal narratives, but is also evident with autobiographical materials (e.g., Levine et al., 2002). This consistency in storytelling in ageing may reflect a preference towards gist representations when encoding and recalling experiences (for a review, see Grilli & Sheldon, 2022).

Despite differences in the production of peripheral details, the finding that older adults present similarities with young adults in the recall of the central and more general meaning of events, suggests a similar processing of the event structure. Nevertheless, results of studies investigating the influence of event structure on memory performance in ageing are mixed. On the one hand, some studies revealed that older adults process the overall structure of continuous everyday-like events similarly to young adults, as they show a preserved ability to use event boundaries to organize the content of experiences (Davis & Campbell 2022; Kurby & Zacks, 2018). On the other hand, other studies reported an age-related reduction in the ability to understand the hierarchical and temporal structure of events (Campbell et al., 2015; Geerligs et al., 2018; Kurby & Zacks 2019; Zacks et al., 2006). Thus, it remains unclear whether the structure of events similarly affects memory performance in young and older adults.

4.1.1. Current study

In the present study, we aimed to address some of these questions: Do older adults similarly benefit from the semantic structure of an experience as young adults? Does the semantic structure of an experience influence recall consistently immediately after encoding and after a period of consolidation? Does the preference for gist emerge progressively over time in older adults? Are participants' narratives consistent over multiple recalls?

To answer these questions, we adopted a paradigm that involves video-based event encoding and multiple recalls over a week. Participants' narratives describing the content of each video were transformed into a network of events based on semantic similarity between events, enabling consideration of the overall structure of an experience (as in Lee & Chen, 2022). Given that highly central events, those with more and stronger semantic connections with others, were found to be more likely recalled immediately after learning than less central ones (Lee & Chen, 2022), we investigated whether the more central events would also be more likely to be consolidated over time and whether this effect would also be evident in older adults.

We had three main predictions. First, given previous studies showing that improving the perception of the temporal structure of events also improves memory after longer delays (Flores et al., 2017), and given the increased reliance on the gist of a memory representation over time (e.g., Winocur & Moscovitch, 2011), we hypothesized that semantic structure of an experience (operationalized as connections between events) would similarly influence recall after a longer delay. In particular, we expected the more central events of a story, those with more and stronger connections to other events, to be retrieved over time and repeated recall more often than the less central ones. Second, given the tendency of older adults to rely more on the gist or general meaning of an experience during memory retrieval (as reviewed in Grilli & Sheldon, 2022), we expected that rich semantic connections between events would support successful retrieval in older adults, as they do in young adults (Lee & Chen, 2022). Third, we wanted to investigate whether participants were consistent in recalling the content of the videos over multiple retrieval sessions. Given that repeated recall tends to stabilize gist-like memory representations (Sekeres et al., 2018; Winocur & Moscovitch, 2011) and prevent the loss of more peripheral information (Sekeres et al., 2016), we expected highly similar participants' narratives over multiple retrievals. Support for this hypothesis also comes from previous work revealing how participants describe events using similar sentences across sessions (Bird et al., 2015) and that errors that emerged in the first recall tend to be remembered in later retrieval of the same event (Roediger et al., 1996; for a review see Roediger & Abel, 2022). To investigate this, we compared the similarity of participants' narratives over time, looking at the consistency of the proportion of events recalled and the amount of repeating words.

Finally, we wanted to investigate whether a preference for gist representations in ageing would be present at the first recall or whether it would become evident over time.

To answer this question, we scored participants' narratives by identifying central and peripheral details (as in St-Laurent et al., 2014) and analysed changes in memory over time and repeated recall (similar to Lifanov et al., 2021). Age differences at the first recall, with a preference for central information over perceptual details in older adults, and a stability of this pattern over time would support the idea that the preference for a gist-like representation does not require a long consolidation period but is evident from the first recall.

4.2. Method

4.2.1. Participants

Thirty-one young and thirty-one older adults were recruited through a local cohort and took part in the study. Participants were screened for neurological and psychiatric disorders, and older adults completed a neuropsychological assessment for global cognition, the Addenbrooke's Cognitive Examination (ACE-III; Hsieh et al., 2013). Of all participants, two young adults were excluded as they did not complete all sessions, one additional young adult and three older adults were excluded due to poor audio recording quality. The final sample was of 28 young (23 female, 5 male; M_{age} = 26.37, SD_{age} = 5.22, range 20 to 34 years) and 28 older adults (22 female, 6 male; M_{age} = 70.73, SD_{age} = 6.03, range 64 to 83 years). All older adults met the eligibility criteria of an ACE-III score above 88 (M = 96.51, SD = 2.46; see Mioshi et al., 2006). Ethics approval was received from the Research Ethics Committee of the School of Psychology at the

University of East Anglia. All participants provided informed consent prior to the start of the experiment and received £12 per hour as compensation.

4.2.2. Stimuli

For the current study, we used 8 videos with sound, which were extracted from short live-action movies available on YouTube (www.YouTube.com). The duration of these videos averaged around 3.67 minutes, with a range between 3.30 to 4.5 minutes. The videos portrayed various life situations (e.g., dad and daughter get ready to go to the park), and their content varied accordingly. To ensure unbiased presentation, the order of the 8 videos was randomized across participants. Each video featured at least one main character, engaging in conversations with other characters. The scenarios presented in the videos encompassed both indoor and outdoor settings. More information about the clips are summarized in **Table 4.1**.

Table 4. 1. Movies information.

Title	Duration	Original Title	Year of release	Director(s)
Dad and daughter go to the park	3.54	How It's Goin'	2019	Irene Chin, Kurt Vincent
Young boy and his motorcycle	3.32	The Fence	2022	William Stone
Woman goes for a walk	3.52	So It Goes	2016	Justin Carlton
Man wakes up with a song in his head	3.30	Gustav	2017	Denis Fitzpatrick, Ken Williams
Teacher and student go to school	3.57	Little Chief	2020	Erica Tremblay
Two young girls working on a farm	4.05	4x4	2020	Ayla Amano
Two young sisters and a ribbon	4.05	Second Best	2018	Alyssa McClelland
First date of two people in a museum	4.02	Wish You Were There	2020	Kieran Thompson

4.2.3. Procedure

The experiment consisted of three distinct online sessions conducted through Microsoft Teams as depicted in **Figure 4.1**. Briefly, in the first session (Day 1, duration was about 1.5 hours), participants engaged in an encoding phase, where they watched 8 videos preceded by a title. The videos were presented using the Gorilla Experiment Builder (Anwyl-Irvine et al., 2020). Following the encoding phase, participants completed an immediate recall phase, during which they were cued with the title of each video and instructed to recall the content of 4 videos from the initial set. After a 24-hours interval (Day 2, duration was about 30 minutes), participants completed the second session. During this session, participants were once again asked to recall the same 4 videos they had recalled the previous day. Finally, one week after the encoding session (Day 8, duration was about 1 hour), participants were instructed to recall the content of all 8 videos from the initial set.

The order in which the videos were presented on Day 1 was randomised across participants. The selection of the videos to be recalled multiple times was pseudo-random, such as each video was recalled a similar number of times between participants (e.g., the first participant recalled videos 1, 2, 3, and 4 multiple times, the second participant recalled videos 5, 6, 7, and 8 multiple times, this third participants recalled the videos 1, 3, 5 and 7 multiple times). The order in which videos were recalled was consistent with the order of encoding (e.g., the order at encoding was 4, 5, 6, 1, 2, 3, 7, and 8; the order of the recall on Days 1 and 2 was 5, 6, 2 and 3; the order recall on Day 8 was 4, 5, 6, 1, 2, 3, 7, and 8).

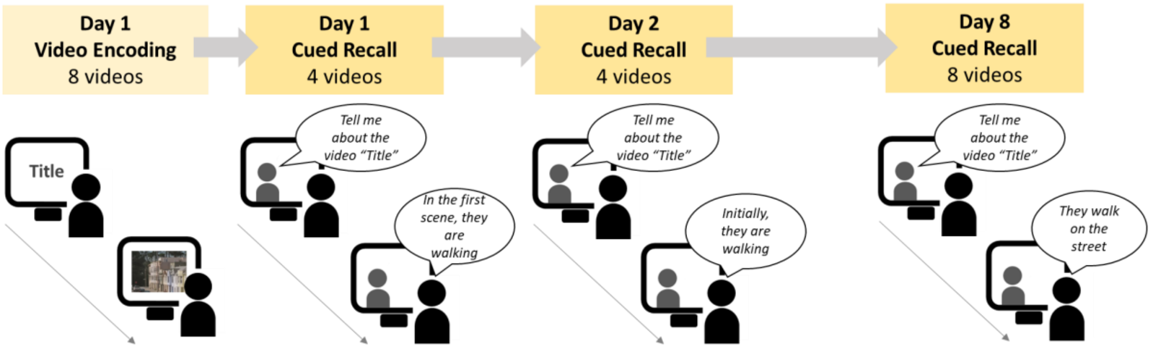

Figure 4. 1. Schematic representation of the testing sessions. On day 1 participants viewed 8 videos. Immediately after encoding, participants verbally recalled 4 of the videos. On the following day (day 2), participants are instructed to recall the same 4 videos they described the previous day. One week after encoding (day 8), participants are instructed to recall the content of all 8 videos, the 4 recalled multiple times and the remaining 4 that participants did not recall in the previous testing sessions.

4.2.3.1. Structure of the encoding phase

During the encoding phase, participants were informed that they would be watching a series of 8 short videos. They were instructed to watch the videos as they would do in their daily life, and they were asked to pay attention to the title of each video. Furthermore, they were informed that their memory for the videos would be tested afterwards. Before the start of each video, the title was displayed for 6 seconds. After watching each video, participants were asked whether they had seen the video previously, and second, whether they were familiar with the topic depicted in that particular video on a scale from 1 "not familiar at all" to 5 "very familiar". One participant has seen one of the videos before, thus the video was excluded from the analysis. Familiarity for the video content, is reported in **Table 4.2,** separate for young and older adults. No difference in familiarity was found between groups (all *p-values* > 0.51).

4.2.3.2. Structure of the retrieval phases

During the retrieval phases, participants were cued with the title of each video and asked to provide a detailed recollection of its content verbally, using their own words (the instructions were: "I am going to ask you to describe, in as much detail as possible, some of the videos that you have watched before. I will give you the title, then will ask you describe the video. Please try to go through the video scene by scene, describing it in as much detail as possible. Now, I will ask you to describe, in as much detail as possible, the video with the title x"). Following this initial free recall, participants were encouraged to elaborate further, providing additional information about the video ("Is there anything else you can remember about this video?"). Finally, participants were asked to rate how detailed they thought their memory for the video was (*vividness*: from 1 "poorly detailed" to 5 "highly detailed"), and how much they remembered about the content and storyline in general (*gist*: from 1 "almost anything" to 5 "almost everything"). In the second (after 24 hours, day 2) and third (after 1 week, day 8) testing sessions, participants were additionally asked to indicate how often they thought about the video outside the testing session (*rehearsal*: from 1 "never" to 5 "almost every day").

4.2.4. Data preparation

4.2.4.1. Video segmentation into events

Following a procedure employed in previous studies (see Chen et al., 2017; Lee & Chen, 2022), each video was segmented into events (for examples, see **Figure 4.2** and **Figure 4.3A**). Each new event started when the researcher detected shifts in the narrative, such as location, topic and time (event boundaries). Subsequently, each event was further divided into finer-grained sub-events, with the researcher providing a detailed description of what occurred in each sub-event, including perceptual details considered relevant to the story. The number and the mean duration of events for each video are summarized in **Table 4.2**. These events identified by the researcher were used as a reference for analysing participants' narratives, while the description of the events made by the researcher served to compute the semantic centrality (see the section below "Semantic Narrative Network and Semantic Centrality"). To assess reliability in the identification of the videos, a researcher N.M. blind to the purpose of the study, segmented each video into finer-grained events, revealing a similar number of events identified (p = 0.98).

Table 4. 2. Number and mean duration of events within videos.

Title	Number of Events	Mean Event Duration (s)	Familiarity Older Adults	Familiarity Young Adults
Dad and daughter go to the park	20	18	2.28 (1.36)	1.79 (1.03)
Young boy and his motorcycle	18	16	1.62 (0.82)	1.86 (1.11)
Woman goes for a walk	18	20	1.45 (0.69)	1.74 (1.06)
Man wakes up with a song in his head	17	19	2.32 (1.19)	2.43 (1.17)
Teacher and student go to school	18	16	1.41 (0.87)	1.21 (0.57)
Two young girls working on a farm	18	22	1.57 (0.93)	1.32 (0.61)
Two young sisters and a ribbon	16	24	1.41 (0.87)	1.48 (0.83)
First date of two people in a museum	16	23	1.97 (1.05)	2.11 (1.34)

Note. No difference in familiarity was found between young and older adults (all p-values > 0.51).

4.2.4.2. Scoring of participants' narratives

Participants' narratives were audio-recorded during the retrieval phases. These recordings were subsequently transcribed automatically and then manually edited by the researcher. Each transcript was segmented into sentences each categorised as follows: 1) *event*: description of events present in the video; 2) *error*: descriptions of an event not present in the video; 3) *comment*: general comments about the video (including gist or abstracted information; e.g. "in the video there are two blonde sisters, one does gymnastic while the other one does not"); and 4) *other*: other types of information (such as repetitions, metacognitive statements, guesses about potential events that could have occurred in the videos and comments unrelated to the content of the video; e.g. "I think that's where it cuts"). In the present study, we focused the analysis on the *event* segments.

An additional scoring previously used in literature (see St-Laurent et al. 2014; Sekeres et al., 2016) was then applied. Each transcript was segmented into finer-grained details with the aim of better characterising recall content. Each detail was categorized as follows: 1) *central details*: unfolding of the story; 2) *peripheral details*: additional descriptive information including perceptual and contextual information present in the videos; 3) *central details error*: descriptions of events that were not present in the videos; 4) *peripheral details errors*: referring to information regarding perceptual and contextual information that is not present in the videos (as in St-Laurent et al. 2014; Sekeres et al., 2016; see **Figure 4.2B**).

A

So this clip was just about a young boy in his family home and he sees a packet of cigarette next to the front door, he looks around to make sure nobody is there and he steals his mum's cigarettes **EVENT_2** and then, I think might have been his dad who lets him go on the motorcycle for like a ride **ERROR** and then he come back home **EVENT_9** and his mum asks him if he's seen her cigarettes and he says no **EVENT_12** he puts a bit of money in her pocket **EVENT_13** and then tries to play it off by saying like oh it is bad for you, you shouldn't smoke **EVENT_14** then he goes on his motorbike again **ERROR**

B

So this clip was just about a young boy **PERIPHERAL** in his family home **PERIPHERAL** and he sees a packet of cigarette next to the front door **PERIPHERAL** **CENTRAL** he looks around to make sure nobody is there **CENTRAL** and he steals his mum's cigarettes **CENTRAL** and then, I think might have been his dad who lets him go on the motorcycle for like a ride **CENTRAL_ERROR** and then he come back home **CENTRAL** and his mum asks him if he's seen her cigarettes **CENTRAL** and he says no **CENTRAL** he walks behind her **CENTRAL** while she is at the sink **PERIPHERAL** and puts a bit of money in her pocket **CENTRAL** and then tries to play it off by saying like oh it is bad for you, you shouldn't smoke **CENTRAL** then he goes on his motorbike again **CENTRAL_ERROR**

Figure 4. 2. Example of the two scoring schemes adopted. A) Example of event identification. Here, the subject included 5 of the events previously identified by the researcher (e.g., Lee & Chen, 2022). B) Example of the detail scoring. Peripheral details refer to perceptual and contextual information. Central elements refer to the unfolding of the event. Central_Error refers to actions and happenings that were not present in the video.

4.2.5. Data analysis

4.2.5.1. Semantic narrative network and semantic centrality

To evaluate and visualize the narrative structure of the videos, we adopted a methodology developed by Lee and Chen (2022), illustrated in **Figure 4.3**. We transformed each video into a network of related events, using the researcher's descriptions of events identifying major shifts in the plot (see the "Video Segmentation into Events" section). We used Google's Universal Sentence Encoder (USE; Cer et al., 2018), a model of language processing built in TensorFlow (https://www.tensorflow.org), to encode the annotations for each event within the videos into high-dimensional vectors, enabling the computation of semantic similarity between pairs of events by calculating the cosine similarity between the USE vectors of pairs of events in the video. The semantic network for each video was constructed with events within a video represented as *nodes*, the connections between events as *edges*, and the *edge weights* as semantic similarity. We then computed the *semantic centrality* of events within a video as the degree of each node (sum of weights of all edges connected to the node) normalized by the sum of degrees and then z-scored within each video. Essentially, the more and stronger connections an event has with other events, the more central it was considered to be in the narrative structure. Semantic narrative networks and semantic centrality were computed using the Spyder interface (version 5.2.2.) for Python (version 3.9.13). All other analyses were computed in R (version 4.2.1), using *lme4* and *tidyverse* packages.

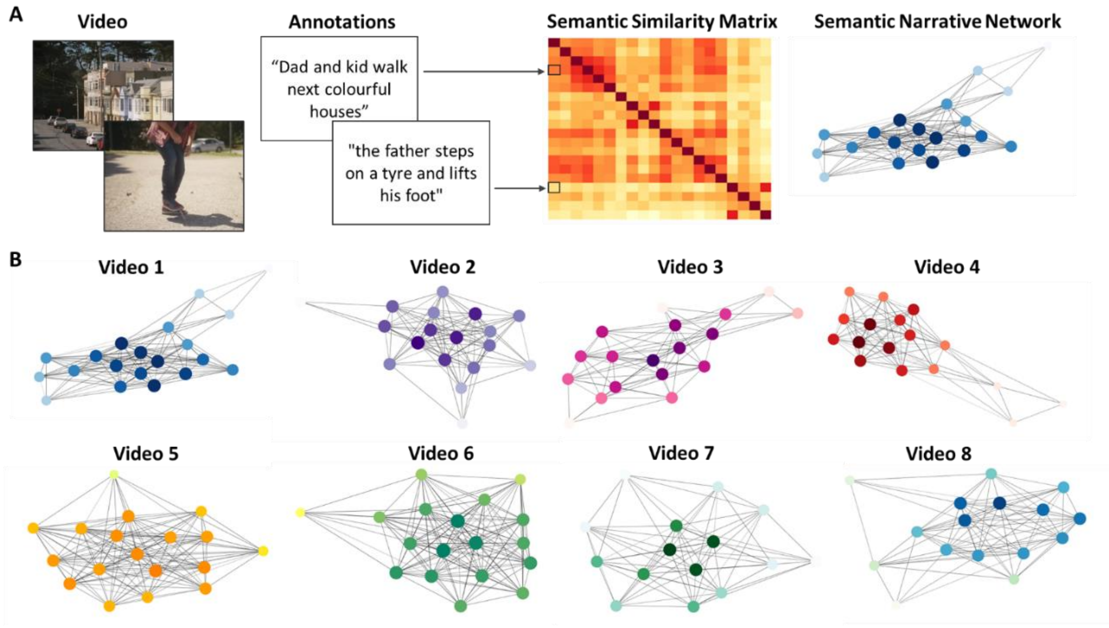

Figure 4. 3. Semantic narrative network generation. A) The annotator watched the video and gave a description of what happened during each event. These descriptions were embedded into vectors using Google's Universal Sentence Encoder (USE). Then, the semantic similarity between events was computed as the cosine similarity between the embedded vectors. For each video, a semantic narrative network was generated with nodes referring to the events and the edge weights as the semantic similarities between events. B) Semantic narrative network visualized for all 8 videos.

4.2.5.2. Recall behaviour and semantic centrality

We examined the effect of semantic centrality on recall performance both immediately after encoding as well as one week after encoding. We ran a logistic mixed model on immediate recall success for each event (1 = recalled, 0 = not recalled), with group (young vs. older adults) and normalized semantic centrality as fixed effects. We ran a logistic mixed models on recall success one week after encoding for each event (1 = recalled, 0 = not recalled), with group (young vs. older adults), recall type (multiple vs. once) and normalized semantic centrality as fixed effects. To account for potential additional variability, we included individual participants and videos as random effects in our models. Only segments of transcripts categorized as "recall of events within videos" were included in this analysis.

4.2.5.3. Analysis of recall content one week after encoding

Overall video recall performance. First, we assessed the overall performance (i.e., whether participants were able to remember the correct video from the corresponding title) when recalling videos one week after encoding. We compared the videos that were recalled multiple times across testing sessions (4 videos were recalled on day 1, day 2 and day 8) with those recalled for the first time after one week (4 videos were only recalled on day 8; recall type). We conducted a logistic mixed model on video recalled (dependent variable; 1 = video recalled, 0 = video not recalled), with group (young vs. older adults) and recall type (multiple vs. one) as fixed factors. To account for individual differences and potential variability across videos, we included individual participants and videos as random effects.

Proportion of events recalled within the videos. Next, we examined the proportion of events recalled within these videos successfully recalled. We compared the proportion of events from videos that were recalled multiple times across testing sessions (4 videos were recalled on day 1, day 2 and day 8) with those recalled for the first time after one week (4 videos were only recalled on day 8; recall type). We conducted a linear mixed model on the proportion of events recalled with group (young vs. older) and recall type (multiple vs. one) as fixed factors, while individual participants and videos were included as random effects. Moreover, we ran multiple Kendall tau rank correlations to investigate whether participants' performance was consistent across recall type, thus to check whether participants that tend to recall more events for the videos recalled multiple times do so also for the videos only recalled once after a week.

Detail recall performance. We then investigated differences in the number and type of details recalled by participants. We conducted a mixed ANOVA on detail counts with detail type (central, peripheral, wrong central, wrong peripheral), and recall type (multiple vs one) as within-subject factors, and group (young vs older adults) as between-subject factor. Bonferroni corrected post hoc analyses were conducted on significant main effects and interactions.

Subjective ratings and recall performance. Finally, we investigated whether subjective ratings of vividness, content and rehearsal correlated with our measure of recall performance over time.

4.2.5.4. Analysis of recall content across testing sessions

Event recall performance. Given the structure of our experimental sessions, we were also interested in investigating differences in participants' recall behaviour across testing sessions, thus comparing the narratives of the 4 videos rehearsed on day 1, day 2 and day 8. To investigate age differences in the proportion of events recalled across testing sessions, we conducted a linear mixed model with group (young vs. older adults) and session (day 1, day 2, day 8) as fixed factors, while individual participants and videos were included as random effects. Moreover, we ran multiple Kendall tau rank correlations to investigate whether participants' performance was consistent across retrieval sessions.

Textual similarity across sessions. To check for consistency in participants' recall across testing sessions and quantify the similarities of their narratives, we computed Jaccard similarities between events descriptions across retrieval sessions, separate for each individual. Jaccard similarity allows to identify the words that overlap between sentences and thus we used it to check for consistency in narrative production across sessions. Jaccard scores range from 0 (no common words) to 1 (complete overlap of words). We then conducted a mixed ANOVA on Jaccard similarity with session (day 1, day 2 and day 8) and group (young vs. older) as factors. Bonferroni corrected post hoc analyses were conducted on significant main effects and interactions.

4.3. Results

4.3.1. Recall behaviour and semantic centrality

4.3.1.1. Recall behaviour and semantic centrality immediately after encoding

As previously found in literature (Lee & Chen, 2022), semantic centrality of events was positively correlated with recall probability immediately after encoding ($r(3846) = 0.14$, $p < .001$, 95% CI = [0.11, 0.17]; See **Figure 4.4**). The logistic mixed model on semantic centrality with recall probability immediately after encoding and group as fixed factors revealed a significant effect of recall probability (beta = 0.32, SE = 0.03, 95% CI [0.26, 0.39], p <.001) indicating that events with high semantic centrality have a higher probability to be recalled than those with lower centrality. The effect of group was not significant (p = 0.27), indicating that semantic centrality similarly predicts recall probability in young and older adults (See **Figure 4.4**).

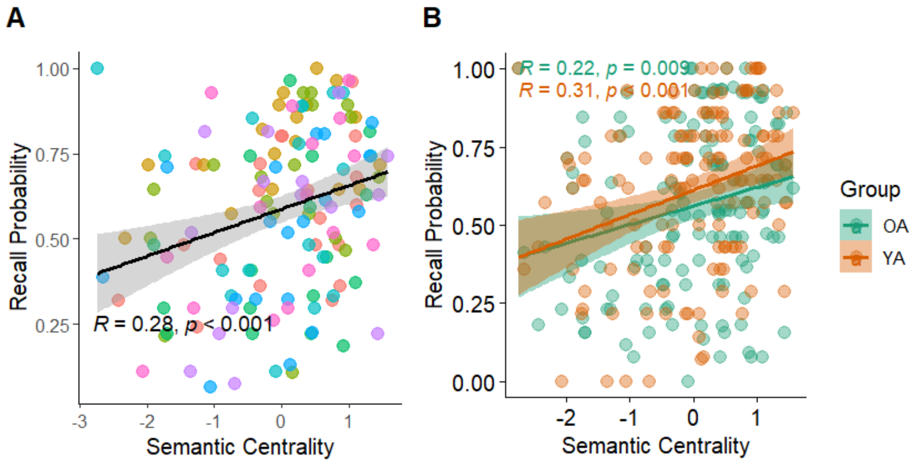

Figure 4. 4. Correlation between recall probability immediately after encoding and semantic centrality. A) Correlation between recall probability on day 1 and semantic centrality. Each dot refers to a specific event. Dots with the same colour refer to the same video. B) Correlation between recall probability on day 1 and semantic centrality, separate for young and older adults. Each dot refers to a specific event.

4.3.1.2. Recall behaviour and semantic centrality one week after encoding

Consistent with our hypothesis, semantic centrality of events was positively correlated with recall probability one week after encoding ($r(138) = 0.29$, $p < .001$, 95% CI = [0.13, 0.44]; See **Figure 4.5**). The logistic mixed model on semantic centrality with recall probability, group and recall type as fixed factors revealed a significant effect of recall probability (beta = 0.33, SE = 0.03, 95% CI [0.28, 0.38], $p < 0.001$), indicating that events with high semantic centrality had a higher probability to be recalled than those with lower centrality. The effect of recall type (multiple vs. one recall) was also significant (beta = -1.02, SE = 0.05, 95% CI [-1.13, -0.91], $p < 0.001$) indicating a higher recall probability for the events within videos recalled multiple times (on day 1, day 2 and day 8) than only once (day 8). However, the effect of group was not significant ($p = 0.19$), indicating that semantic centrality similarly predicted recall probability in young and older adults (See **Figure 4.5**).

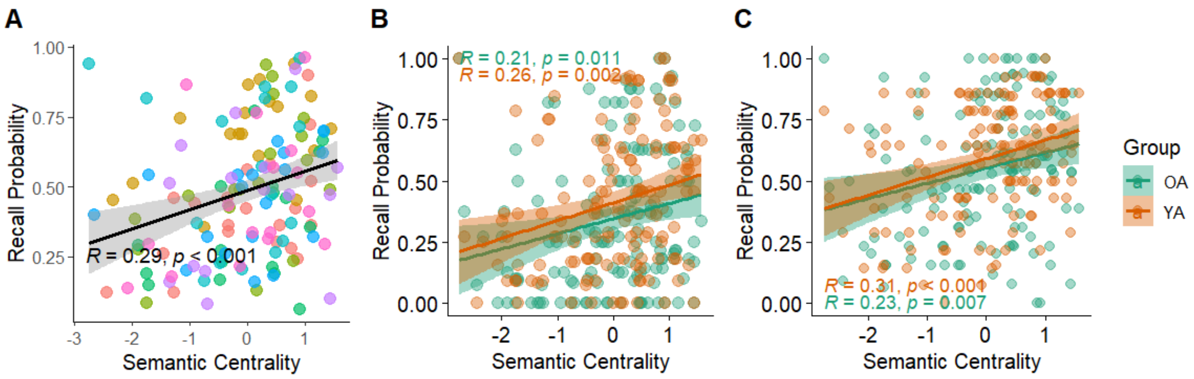

Figure 4. 5. Correlation between recall probability one week after encoding and semantic centrality. A) Correlation between recall probability one week after encoding and semantic centrality. Each dot refers to a specific event. Dots with the same colour refer to the same video. B) Correlation between recall probability on day 8 for the videos recalled multiple times and semantic centrality, separate for young and older adults. Each dot refers to a specific event. C) Correlation between recall probability on day 8 for the videos recalled only once and semantic centrality, separate for young and older adults. Each dot refers to a specific event.

4.3.2. Recall behaviour one week after encoding

4.3.2.1. Overall video recall performance

One week after encoding, participants recalled on average 98% (*SD* = 0.11) of the videos that were recalled multiple times (young adults: *M* = 0.99, *SD* = 0.09; older adults: *M* = 0.98, *SD* = 0.13), and 79% (*SD* = 0.37) of the videos that were only recalled one week after encoding (young adults: *M* = 0.88, *SD* = 0.32; older adults: *M* = 0.79, *SD* = 0.41). The logistic mixed model had a substantial explanatory power (conditional R2 = 0.55; marginal R2 = 0.32) and revealed a significant effect of recall type (beta = -2.89, 95% CI

[-5.00, -0.78], $p = 0.007$), with participants recalling more videos that have been recalled multiple times ($M = 0.99$, $SD = 0.11$) compared to those recalled only once after one week ($M = 0.83$, $SD = 0.37$, $t(223) = 5.75$, $p < 0.001$, $d = 0.56$, 95% CI [0.35, 0.76]). The main effect of group and the interaction between these factors were not significant ($p > 0.55$).

4.3.2.2. Proportion of events recalled within the videos

We then analysed the proportion of events recalled within videos one week after encoding. The linear mixed model had a substantial power (conditional R2 = 0.67; marginal R2 = 0.21) and revealed a significant effect of recall type (beta = -0.23, 95% CI [-0.28, -0.19], $t(389) = -11.27$, $p < .001$), with participants recalling a higher proportion of events from videos recalled multiple times ($M = 0.57$, $SD = 0.21$) compared to those recalled only once after one week ($M = 0.38$, $SD = 0.20$, $d = 0.91$). However, the effect of group and the interaction between these factors were not significant ($p > 0.14$). Additionally, we found that young and older participants with higher proportion of recalled events for the videos recalled multiple times also had a higher proportion of recalled events for videos recalled only one week after encoding (young adults: $\tau = 0.61$, $p < 0.001$; older adults: $\tau = 0.31$, $p = 0.02$), indicating an individual consistency in recall behaviour regardless of the delay between encoding and retrieval (See **Figure 4.6A**).

4.3.2.3. Details recall performance

We then took a closer look into participants' recollections and compared the number of details produced when describing videos recalled multiple times with those recalled only once (recall type). The mixed ANOVA on details counts revealed a main effect of details

($F(3, 428) = 217.38$, $p < 0.001$, partial η2 = 0.60, 95% CI [0.56, 1.00]), a main effect of recall type ($F(1, 428) = 19.56$, $p < 0.001$, partial η2 = 0.16, 95% CI [0.11, 1.00]), with participants reporting more details for the videos recalled multiple times ($M = 8.35$, $SD = 9.32$) than only once after a week ($M = 4.46$, $SD = 5.21$), a main effect of group ($F(1, 428) = 19.56$, $p < 0.001$, partial η2 = 0.04, 95% CI [0.02, 1.00]), with young adults ($M = 7.39$, $SD = 9.14$) reporting more details than older adults ($M = 5.45$, $SD = 6.03$), a significant interaction between detail type and group ($F(3, 428) = 7.20$, $p < 0.001$, partial η2 = 0.05, 95% CI [0.02, 1.00]), and a significant interaction between detail type and recall ($F(3, 428) = 23.91$, $p < 0.001$, partial η2 = 0.14, 95% CI [0.09, 1.00]), while the other interactions were not significant (all *p-values* > 0.53).

Post-hoc analysis on the main effect of details type revealed that participants recalled a similar number of central ($M = 12.3$, $SD = 6.81$) and peripheral details ($M = 11.07$, $SD = 12.03$; $p = 0.62$), but more central details than central errors ($M = 1.06$, $SD = 0.74$; $t(113.32) = 17.19$, $p < 0.001$, 95% CI [9.90, 12.48]), and peripheral errors ($M = 0.63$, $SD = 0.67$; $t(112.14) = 17.91$, $p < 0.001$, 95% CI [10.34, 12.91]), as well as more peripheral detail than central errors ($t(112.12) = 13.16$, $p < 0.001$, 95% CI [9.07, 12.28]) and peripheral errors ($t(111.37) = 13.72$, $p < 0.001$, 95% CI [9.51, 12.72]). Also, they produced more event errors than peripheral errors ($t(210.2) = 4.27$, $p < 0.001$, 95% CI [0.23, 0.63]).

Post hoc analysis on the interaction between detail type and group revealed that young adults recalled more central details ($t(96.5) = -3.39$, $p = 0.004$, 95% CI [-6.61, -1.73]), and more peripheral details ($t(89.2) = -2.38$, $p = 0.02$, 95% CI [-6.87, -0.62]), while no difference was found for peripheral errors and central errors (all *p-values* > 0.08).

Post hoc analysis on the interaction between detail type and recall revealed that participants recalled more central details ($t(99.1) = 6.55$, $p < 0.001$, 95% CI [5.01, 9.36]) more peripheral detail ($t(90) = 5.56$, $p < 0.001$, 95% CI [5.10, 10.8]) and also more peripheral errors ($t(93.7) = 2.42$, $p = 0.02$, 95% CI [0.05, 0.55]) but not more central errors ($p = 0.42$) for videos recalled multiple times than only once after one week from encoding (See **Table 4.3** and **Figure 4.6B**).

Table 4. 3. Mean number of detail types recalled after 1 week from encoding (standard deviation) for young and older adults.

	Older		**Young**	
	Multiple	One	Multiple	One
Central	13.4 (4.38)	6.81 (3.46)	18.30 (7.70)	10.40 (5.17)
Peripheral	13.6 (5.41)	5.98 (3.58)	17.80 (11.50)	9.43 (6.41)
Central Errors	1.06 (0.70)	1.02 (0.85)	1.19 (0.90)	0.98 (0.90)
Peripheral Errors	0.90 (0.72)	0.57 (0.57)	0.65 (0.83)	0.38 (0.41)

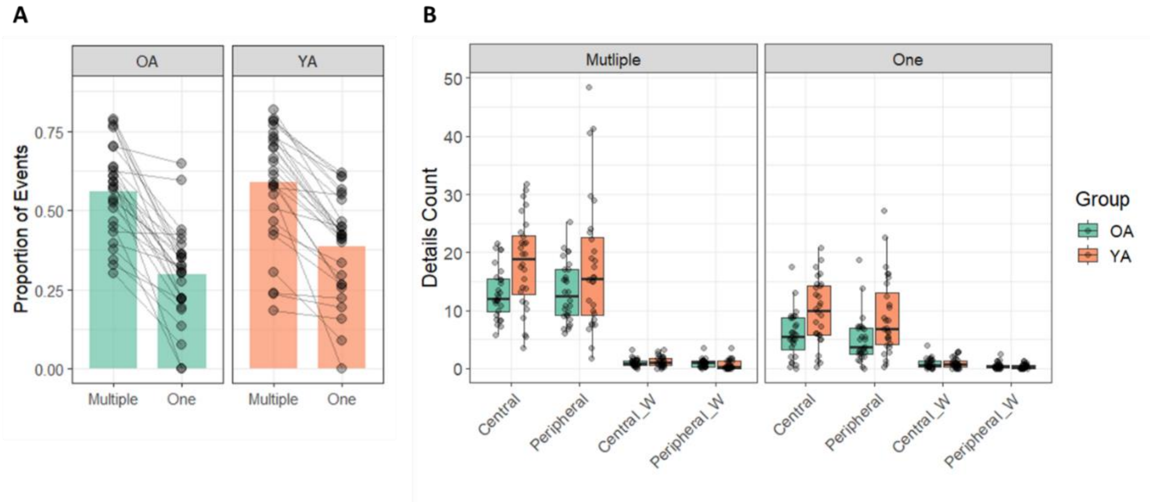

Figure 4. 6. Recall behaviour one week after encoding. A) Proportion of event recalled across videos one week after encoding. Participants recall more events for the videos that has been recalled multiple times than the videos recalled after one week. B) Boxplot describing the number of details (event, peripheral and errors) reported for videos recalled multiple times (on day 1, day 2 and day 8) and those only after one week from encoding (only on day 8). OA = older adults. YA = young adults. Central_W: central errors; Peripheral_W: peripheral errors.

4.3.2.4. Subjective ratings and recall probability

Rehearsal ratings. Considering the videos recalled multiple times, we found no correlation between rehearsal, how often participants thought about the videos outside the testing sessions, and the proportion of events recalled in young nor older adults (all *p-values* > 0.34; see **Figure 4.7A**). Looking at the videos recalled only once after a week from encoding, we found a positive correlation between rehearsal ratings and the proportion of events recalled in young ($r(109) = 0.30$, $p = 0.001$, 95% CI [0.12, 0.46]) and older adults ($r(110) = 0.37$, $p < 0.001$, 95% CI [0.20, 0.52]), showing that the more participants thought about the video outside the testing session the more events they recalled (see **Figure 4.7B**).

Vividness ratings. We then analysed the vividness ratings collected after participants recalled the content of each video. Analysing vividness ratings for narratives of videos recalled multiple times, we found a positive correlation between vividness and event recall probability - proportion of events recalled - in young ($r(111) = 0.48$, $p < 0.001$, 95% CI [0.32, 0.61]) and older adults ($r(110) = 0.56$, $p < 0.001$, 95% CI [0.40, 0.66]), showing that narratives were considered as more vivid when they were also richer in events recalled (See **Figure 4.7C**). Analysing vividness ratings for narratives of videos recalled only once, we similarly found a positive correlation between vividness and event recall probability in young ($r(109) = 0.69$, $p < 0.001$, 95% CI [0.55, 0.76]) and older adults ($r(110) = 0.80$, $p < 0.001$, 95% CI [0.72, 0.86]), showing that even narratives of video recalled only once were considered as more vivid when they were also richer in events recalled (see **Figure 4.7D**).

Content ratings. Finally, we analysed the content ratings, referring to how much of the storyline they feel are remembering, collected after participants recalled the content of each video. Analysing content ratings for narratives of videos recalled multiple times, we found a positive correlation between content and event recall probability in young ($r(111) = 0.52$, $p < 0.001$, 95% CI [0.37, 0.64]) and older adults ($r(110) = 0.52$, $p < 0.001$, 95% CI [0.37, 0.64]), showing that participants considered as richer in storyline the narratives for which they also reported more events (see **Figure 4.7E**). Analysing content ratings for narratives of videos recalled only once, we found a positive correlation between content and event recall probability in young ($r(109) = 0.67$, $p < 0.001$, 95% CI [0.55, 0.76]) and older adults ($r(110) = 0.77$, $p < 0.001$, 95% CI [0.69, 0.84]), showing that participants considered as richer in storyline the narratives for which they also included more events (see **Figure 4.7F**).

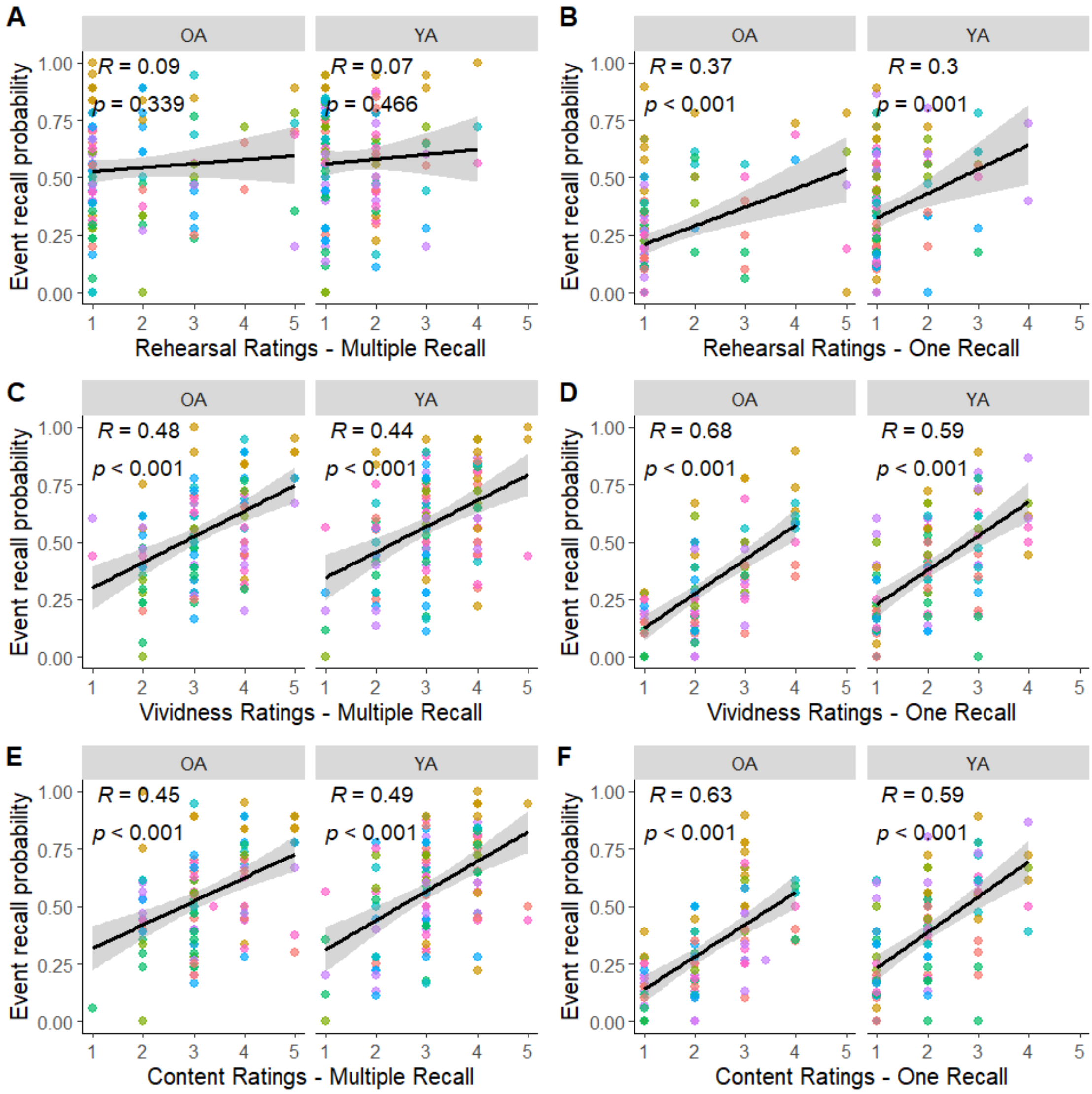

Figure 4. 7. Correlation between event recall probability on day 8 and subjective ratings. A) Correlation between recall probability and rehearsal for videos recalled multiple times, separate for young (YA) and older adults (OA). Each dot refers to a specific event. Dots with the same colour refer to the same video. B) Correlation between recall probability and rehearsal for videos recalled only once, separate for young and older adults. C) Correlation between recall probability and vividness for videos recalled multiple times, separate for young and older adults. D) Correlation between recall probability and vividness for videos recalled only once, separate for young and older adults. E) Correlation between recall probability and content ratings for videos recalled multiple times, separate for young and older adults. D) Correlation between recall probability and content ratings for videos recalled only once, separate for young and older adults.

4.3.3. Recall behaviour across testing sessions

Next, we focused on the videos that had been recalled multiple times across testing sessions, looking at how the recollection changed over time (comparing narratives in day 1 with those in day 2 and day 8).

4.3.3.1. Proportion of events recalled within the videos

First, we looked at the proportion of events recalled across testing sessions. The linear mixed model on the proportion of events recalled across sessions (accuracy ~ group * session) has a substantial power (conditional R2 = 0.71; marginal R2 = 0.009) but revealed no effect of group, session nor interaction between them (all *p-values* > 0.26). Moreover, we found the proportion of recalled events across sessions to be consistent both in young (Day1-Day2: $\tau = 0.81$, $p < 0.001$; Day2-Day8: $\tau = 0.81$, p < 0.001; Day1-Day8: $\tau = 0.84$, $p < 0.001$) and older participants (Day1-Day2: $\tau = 0.71$, $p < 0.001$; Day2-Day8: $\tau = 0.71$, $p < 0.001$; Day1-Day8: $\tau = 0.64$, $p < 0.001$; See **Figure 4.8A**).

4.3.3.2. Textual Similarity

The mixed ANOVA on average Jaccard similarity revealed a main effect of retrieval session (F(2,5484) = 58.21, $p < 0.001$, partial η2 = 0.02, 95% CI [0.01, 1.00]), but no main effect of group, nor any interactions between these factors (all *p-values* > 0.45). Post hoc analyses revealed a significant increase in Jaccard similarity when comparing retrieval sessions over time, such as the similarity between day 2 and day 8 (M = 0.28, SD = 0.11) was higher than between day 1 and day 8 (M = 0.24, SD = 0.10; t(1829) = -

14.2, $p < 0.01$, d = -0.33, 95% CI [-0.04, -0.03]), and between day 1 and day 2 (M = 0.26, SD = 0.11; t(1829) = -5.56, $p < 0.01$, d = -0.13, 95% CI [-0.02, -0.01]).

4.3.3.3. Detail recall performance

Looking now at the production of details for the videos recalled multiple times across testing sessions, the mixed ANOVA on details count revealed a main effect of detail (F(3, 656) = 457.37, $p < 0.001$, partial η2 = 0.68, 95% CI [0.65, 1.00]), a significant main effect of group (F(1, 468) = 20.25, $p < 0.001$, partial η2 = 0.03 95% CI [0.01, 1.00]), with young adults (M = 8.71, SD = 10.0) including more details than older adults (M = 7.03, SD = 7.08), and a significant interaction between detail type and group (F(3, 656) = 1.64, $p <$ 0.001, partial η2 = 0.03, 95% CI [0.01, 1.00]), while no main effect of testing session nor other interactions were found significant (all *p-values* > 0.06).

Post hoc analysis on the main effect of details type revealed that participants recall a similar number of central (M = 15.6, SD = 6.21) and peripheral details (M = 14.2, SD = 7.98; p = 0.48), as well as a similar number of central error (M = 0.85, SD = 0.66) and peripheral errors (M = 0.80, SD = 0.81; p = 0.99). Moreover, they produce more central details than central errors (t(170.81) = 30.61, $p < 0.001$, 95% CI [13.80, 15.70]), and peripheral errors (t(172.69) = 30.64, $p < 0.001$, 95% CI [13.85, 15.75]), as well as more peripheral detail than central errors (t(169.30) = 21.65, $p < 0.001$, 95% CI [12.16, 14.60]) and peripheral errors (t(170.45) = 21.70, $p < 0.001$, 95% CI [12.21, 14.66]).

Post hoc analysis on the interaction between detail type and group revealed that young adults recalled more central details (t(84) = -3.65, $p < 0.001$, 95% CI [-5.20, -1.54]), and more peripheral detail (t(84) = -2.84, p = 0.005, 95% CI [-5.81, -1.03]), while no difference was found for event and peripheral errors (all *p-values* > 0.67; See **Table 4.4** and **Figure 4.8B**).

Table 4. 4. Mean number of detail types recalled across different sessions (standard deviation).

	Older			**Young**		
	Day 1	Day 2	Day 8	Day 1	Day 2	Day 8
Central	14.21 (5.28)	14.17 (4.43)	10.57 (3.29)	16.86 (6.71)	16.74 (6.91)	14.58 (5.99)
Peripheral	11.38 (4.45)	12.61 (4.67)	10.15 (3.72)	14.34 (8.08)	15.73 (9.94)	13.85 (8.64)
Central Errors	0.67 (0.56)	0.83 (0.57)	1.04 (0.65)	0.58 (0.45)	0.78 (0.53)	1.09 (0.74)
Peripheral Errors	0.59 (0.45)	0.98 (0.65)	0.55 (0.45)	0.70 (0.65)	0.97 (1.28)	0.52 (0.57)

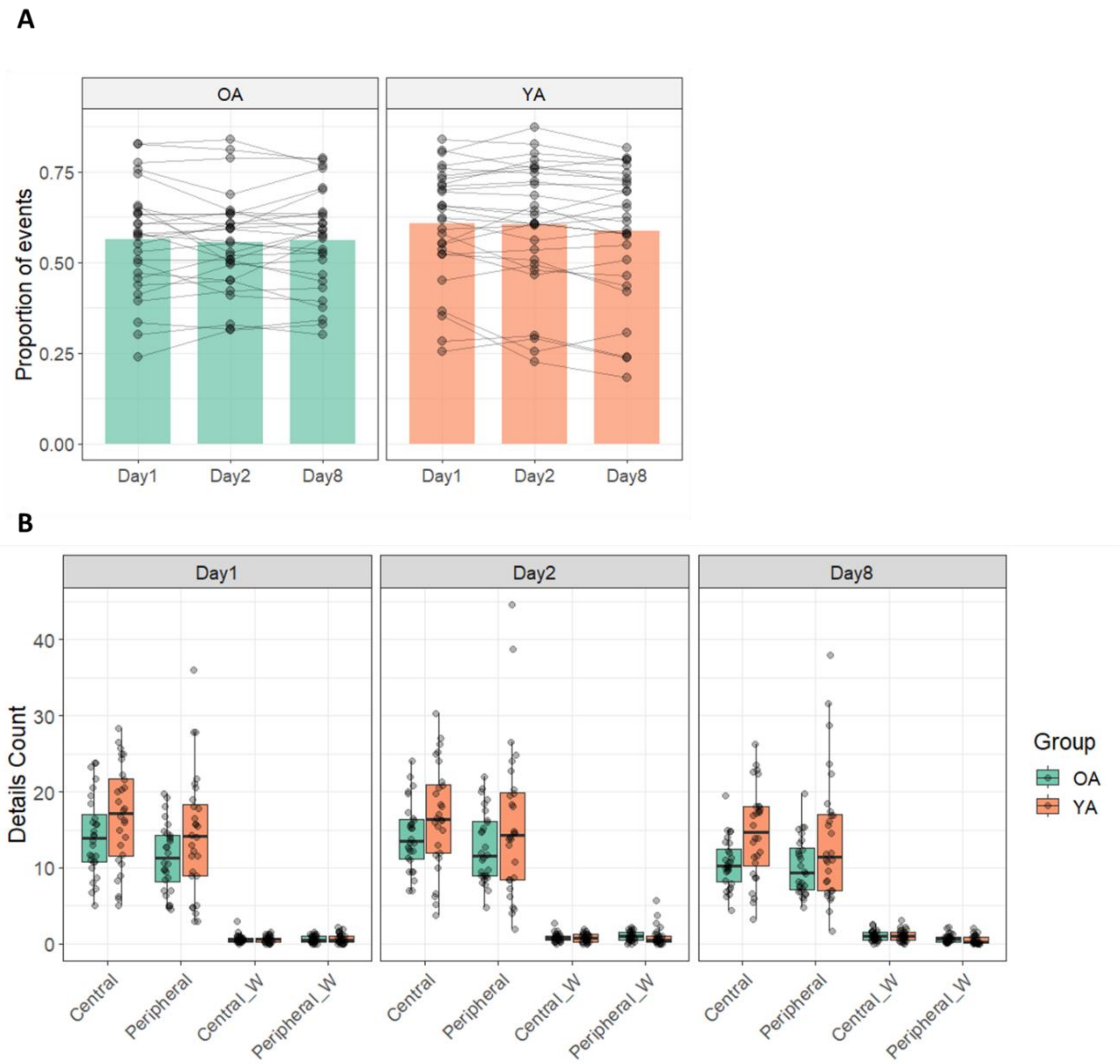

Figure 4. 8. Recall behaviour across testing sessions. A) Proportion of events recalled across sessions in young and older adults. Participants recalled a similar proportion of events immediately after encoding (day 1), 24-hours after encoding (day 2) and one week after encoding (day 8). B) Boxplot describing the number of details (event, peripheral and errors) reported for videos recalled at different times from encoding. OA = older adults. YA = young adults. Central_W: central errors; Peripheral_W: peripheral errors.

4.4. Discussion

The present study aimed to investigate the influence of the semantic structure of events, based on inter-events connections, on memory recall in young and older adults, especially after a period of consolidation. Participants viewed different videos representing life-like situations and then described the content of the video immediately after encoding (day 1), after one day (day 2), and after one week (day 8). Participants' narratives were transformed into semantic networks, adopting a recently developed natural language model, where events served as nodes connected by edges reflecting semantic similarity of events. Participants' narratives were also scored looking at details production, separating the elements that are central to the storyline and the peripheral information. The findings revealed that the semantic structure influenced recall not only immediately after encoding, but also after a period of consolidation, as seen by a higher recall probability for events with higher semantic centrality one week after encoding. Moreover, the semantic structure of events similarly influences recall in young and older adults. Age differences were also absent when comparing the proportion of events within videos recalled one week after encoding and across testing sessions. Both young and older adults benefitted from multiple retrievals of the video content, as shown by recollections that were consistent over testing sessions. Age differences emerged when considering details production in participants' narratives, such as young adults include more central and peripheral details, resulting in richer descriptions than older adults. Below, the different findings are elaborated and connected with the broader literature.

4.4.1. Semantic centrality influences recall behaviour

Our results extend prior work showing that the semantic structure of events supports successful memory retrieval, not only immediately after encoding (as in Lee & Chan, 2022), but also one week later. Indeed, in our study, events with higher semantic centrality, indicating more and stronger connections to other events in the narrative, were more likely to be successfully recalled immediately after encoding as well as one week later. Previous work showed how the structure of an event plays a role in organizing information into coherent narratives, as participants with better event segmentation abilities also presented better memory retrieval after a period of consolidation (Cohn-Sheehy et al., 2021; Flores et al., 2017). Our results complement these findings by showing that the semantic connections between events beyond their temporal proximity also influences how memory are recalled. Support to our findings also come from studies revealing that semantically well-connected information (for a review see Brod et al., 2013) and events that follow a recognizable script (Baldassano et al., 2018) are better remembered. The absence of age difference is coherent with findings revealing that older adults benefit from semantic relatedness during encoding and retrieval, showing a beneficial effect on episodic memory performance when stimuli are interrelated (Naveh-Benjamin et al., 2005; Naveh-Benjamin et al., 2003). Additionally, the relevance of semantic relatedness in the present study might be increased by the nature of the stimuli used. Indeed, the videos selected described ordinary life scenarios that likely allowed participants of both age groups to rely on prior schema knowledge (Brod et al., 2013; Umanath & Marsh 2014).

4.4.2. Age similarities and differences in memory recall

Our study revealed no age differences in the proportion of events recalled within videos. One week after encoding, older adults recalled a similar amount of events than young adults. Throughout testing sessions, older and young participants similarly benefitted from multiple recall, as shown by a similar consistency in the proportion of events within videos recalled. The analysis of the proportion of events recalled from the previously seen videos was based on whether the event, representing major changes in the plot, was present or absent in participants' recollections, without taking into account how participants described it. Thus this analysis and scoring approach looked at participant ability in recalling the gist of the story. Considering the preference for older adults towards the gist, the overarching meaning or essence of events, rather than specific details (as reviewed by Grilli & Sheldon, 2022), the absence of age-related differences in the proportion of main events recalled is unsurprising. This observed similarity in overall recall suggests that both young and older adults effectively integrated the event gist information into their narratives.

Age differences in recall emerged when considering the details included in participants' narratives. Older adults included fewer central and peripheral details than young adults, while no difference was found for the errors made. Moreover, this pattern was evident since the first retrieval (i.e., at day 1) and remained constant across sessions. The analysis of detail production assessed participants' ability to recall finer-grained specifics about the story, such as sequences of actions, perceptual information, and contextual details. Thus, while remembering the general storyline, the gist of the story, is sufficient for overall recall performance when considering the proportion of events recalled, it is insufficient for recalling the specific details that characterize the story. These results are consistent with the literature on ageing and memory describing a reduced specificity when older adult recall autobiographical memories (Levine et al., 2002; Piolino et al., 2002) and non-personal experiences (Gaesser et al., 2011; Sacripante et al., 2019).

Our findings suggest that the preference for gist-based memory representations doesn't seem to develop gradually over time but may be established right from the initial recall. We observed that both young and older adults maintained consistent narrative patterns across multiple testing sessions and exhibited a similar reduction in the proportion of details when describing videos one week after initially viewing them. However, age-related distinctions were apparent, with older adults recalling fewer central and peripheral details both immediately after encoding and one week later. This implies that the semanticisation of memories often associated with aging appears to manifest from the very first recall and appears to be intertwined with changes occurring over time, similar to what is observed in young adults (e.g., Winocur & Moscovitch, 2011).

4.4.3. Recall across sessions

Another aim of the present study was to examine the consistency of recall across testing sessions. When considering the proportion of events recalled within videos and at the finer-grained production of central and peripheral details, participants showed consistent performance over repeated recall sessions. Moreover, young and older adults recalled a higher proportion of events, as well as more central and peripheral details, for videos recalled multiple times compared to those recalled only once. This pattern highlights the beneficial effect of active repeated retrieval in strengthening memory representations (Bird et al., 2015; Sekeres et al., 2016) and in increasing their accessibility at retrieval (Sutterer & Awh, 2015; Antony et al., 2017). Indeed, the stability of the memory representations over time, analysed by looking at the proportion of events and details recalled over time, and the increased similarity of narratives over time, analysed by considering the consistency of verbal descriptions, both support the idea that repeated rehearsal increases the accessibility of the main events and details previously recalled. This stability in recall behaviour also suggests a potential impact of trait like tendencies in memory retrieval, as also hinted by a consistency in the proportion of event recalled across sessions within participants, and the importance of individual differences in narrative style (Bluck et al., 1999; Bluck et al., 2016; see also Schacter et al., 2012).

Interestingly, we found no age difference in the benefit of repeated retrieval. Previous work revealed that retrieval practice benefits young participants more than older adults (Meyer & Logan, 2013; Guran et al., 2020). In our study the absence of age differences may be related to the specific stimuli used. While age differences might emerge when using laboratory-based stimuli, adopting naturalistic stimuli such as videos at encoding might improve older adults' performance (e.g., Davis et al., 2021).

4.4.4. Conclusion

In this study we adopted a natural language model to investigate memory retrieval and showed how the semantic structure of events, operationalized as the number and strength of connections among events, similarly influences memory recall in young and older adults and that this effect remained constant after a period of consolidation. Moreover, while both young and older adults exhibited comparable abilities in retrieving the central meaning of events, age-differences emerged when considering the richness of detail included in their narratives. Our findings highlight the need of using more naturalistic stimuli to investigate age-related changes in older adults, looking beyond the episodic memory decline and understanding which forms of memories are preserved and preferred in ageing. More broadly, these findings contribute to our understanding of memory processes in ageing and highlight opportunities for memory interventions that leverage the natural changes occurring with age, such as a preference for gist-based memory, and the use of video footage, pictures and repeated retrieval (as demonstrated by the positive effect of Sense Cam in improving memory, e.g. Browne et al., 2011; Mair et al., 2017).

4.4.5. Acknowledgements

We would like to thank Kayla Smith for help with data collection, transcriptions and scoring of young adults' recollections. We would like to thank Dr. Hongmi Lee for their feedback and advice.

Chapter 5

General Discussion

The present thesis aimed to understand and characterise the nuances of age-related differences in declarative memory recall. Specifically, the primary focus was to understand age-related differences in recall beyond the traditional characterisation of ageing as a process marked by a decline in episodic memory alongside the preservation of semantic knowledge. To achieve this, the experiments reported in the thesis manipulated retrieval instructions targeting episodic and semantic memories, and examined participants' narratives by analysing the production of intermediate forms of declarative memories, particularly personal semantics and gist representations. I developed naturalistic paradigms involving narrative-like encoding, by targeting personal events (Chapters 2 and 3) and adopting fictional stories (Chapter 4), followed by narrative-like retrieval, asking participants to remember and verbally describe these stories. Across all experiments, two consistent findings emerged: when elaborating autobiographical and fictional narratives, participants tended to recall a mixture of perceptual and contextually specific details but also gist-like and schematic information; older adults particularly preferred personal semantic knowledge (Chapters 2 and 3) and gist-like representations (Chapter 4) over more finer-grain details when recalling personal and fictional past experiences.

In the subsequent sections, this chapter will delve into the findings of each experimental study and their connections to the broader existing literature.

5.1. Summary of findings

In Chapter 2, we manipulated the instructions of the Autobiographical Interview (AI; Levine et al., 2002), a widely used interview to investigate episodic content. We designed the Semantic Autobiographical Interview (SAI) to elicit personal and general semantic content in a narrative form in different sections of the interview. Our findings indicated that the characteristic tendency of older adults to recall past events with more non-target details than young adults, particularly semantic information, was also evident when constructing personal and general semantic narratives. Nevertheless, both age groups modulated the content of their narratives depending on the instructions. Indeed, episodic details were greatest on the standard AI, personal semantic details were greatest on the personal semantic section of the interview (P-SAI), and general semantic details characterized the general semantic section (G-SAI). Moreover, our results revealed a consistent proportion of target details between the AI and the P-SAI, suggesting a trait-level consistency in the production of on-task or probed details. Looking at the specific pattern of details within narratives, we observed that regardless of task instructions, older adults displayed a preference towards the production of personal semantic content. This preference hinted at a shift towards more gist-like representations when recalling the past (as described in Grilli & Sheldon, 2022).

Chapter 3 built upon the findings of Chapter 2 by manipulating task instructions and demands, requiring participants to switch between episodic and semantic retrieval. We adapted the Alternate Instruction Autobiographical Memory Test (AMT-AI; Dritschel et al., 2014) to allow for a randomized switch between episodic and semantic retrieval instructions. The episodic (specific) instructions prompted participants to recall unique events from their past, while the semantic (categoric) instructions prompted participants to recall repeated events. The analysis considered recall consistency and coherence with instructions (e.g., recalling a specific event when instructed to do so) as well as details production (e.g., episodic details, repeated event details, and semantic knowledge). The results revealed that when participants switched between episodic and semantic recall, older adults' performance was reduced compared to young adults, while no difference in performance was observed when participants were instructed to recall either episodic or semantic memories in separate blocks. These findings echo those of Chapter 2, where participants effectively incorporated in their narratives content that was coherent with the given instructions (e.g., telling about a specific event when instructed to recall an episodic memory), but also hinted at a role of control processes during memory retrieval particularly when tasks demands increase (Amer et al., 2022; Craik & Bialystok, 2006; Turner & Spreng, 2015; Spreng et al., 2018). The analysis on details production revealed a lower proportion of probed details in older adults' narratives of unique and repeated events, but a consistent higher proportion of semantic information than young adults. This finding also aligns with results from Chapter 2, revealing a bias for semantic production when recalling the past.

To maintain the narrativization of memories typical of autobiographical memory studies while overcoming the lack of control over encoding, in Chapter 4 we adopted a naturalistic yet laboratory-based study. Participants were presented with a series of videos depicting everyday life situations and were then asked to recall the videos content immediately after encoding, after one day, and after one week. Participants' narratives were then analysed with a similar approach undertaken in Chapters 2 and 3, which involved the examination of the details included in the narratives. As a novel approach, we also adopted a natural language model to examine the connections between events. Our findings revealed age differences in details production, with older adults incorporating fewer perceptual and event details than young adults (for similar results, see Sacripante et al., 2019; Davis et al., 2021; Delarazan et al., 2022; Taler et al., 2021). Despite the difference in details production, older adults exhibited a comparable ability to young adults in processing the narrative structure of an experience. Importantly, the consistent benefit of semantic centrality on memory performance remained stable after a period of consolidation. The findings from Chapter 4 therefore align with those of Chapters 2 and 3, revealing a preservation of more general representations during recall in ageing, despite a reduction in specific details as compared to young adults.

5.2. Nuances of declarative memory in ageing adopting naturalistic approaches

Examining narrative recall represents a valuable approach for studying naturalistic memory, particularly in the context of age-related research. Typically, individuals are prompted to remember specific events from their past or stories they encoded from videos or written text. When elaborating narratives for these events, participants tend to incorporate a variety of non-episodic content, including personal or general semantic information (e.g., Acevedo-Molina et., 2019; Addis et al., 2008; Levine et al., 2002, Renoult et al., 2020; St-Jacques & Levine, 2007; Strikwerda-Brown et al., 2018), but also more general and gist-like information (e.g., Bird et al. 2015; Sekeres et al., 2016). Notably, this incidental inclusion of non-episodic details when remembering personal and non-personal events is more prevalent among older individuals (e.g., Acevedo-Molina et., 2019; Addis et al., 2008; Davis et al., 2021; Delarazan et al., 2022; Levine et al., 2002; Renoult et al., 2020; Sacripante et al., 2019; St-Jacques and Levine, 2007; Strikwerda-Brown et al., 2018; Taler et al., 2021). As previously found in literature (e.g., Renoult et al., 2020), the results described in Chapters 2 and 3 suggest that the elevated production of non-episodic details, which typically occurs in ageing, is specifically characterised by an increased production of semantic information, particularly personal semantic. The novelty of the presented studies comes from the manipulation of the instructions, which allowed us to investigate different types of autobiographical memories. In Chapter 2, both age groups showed a preference for autobiographical facts and self-knowledge information when instructed to describe personal life chapters. Interestingly, autobiographical facts and self-knowledge information also comprised the most common off-task utterances among older adults when describing unique events and general knowledge. Chapter 3 yielded similar results, revealing that older adults tended to recall more off-task semantic information compared to young adults, whether they are instructed to recall unique or repeated events. Interestingly, this result was constant regardless of the increased task demands due to switching between episodic and semantic retrieval modes, revealing specific narrative styles and preferences that emerge in ageing. Previous studies have shown a similar preference for semantic information, regardless of the specific instructions given to participants (e.g., Ford et al., 2014; Strikwerda-Brown et al., 2021). As discussed below, this findings suggests that older adults' off-task recall is not merely content excluded by instructions (i.e., episodic details when given semantic instructions), nor repetitions or metacognitive statements. Rather, older adults are biased towards the production of personal semantic information that is both adaptive and meaningful to them (for a review see Grilli & Sheldon, 2022).

Beyond autobiographical narratives, people tend to use a mixture of perceptual and contextually specific detailed intertwined with gist-like and schematic information also when remembering non-personal events (e.g., Bird et al. 2015; Sekeres et al., 2016). In Chapter 4, we showed that older adults exhibited a reduction in central and peripheral details, referring to characters' actions in the videos and to perceptual information respectively, while retaining the gist of the experiences (similarly to Davis et al., 2021; Delarazan et al., 2022; Sacripante et al., 2019; Taler et al., 2021). Importantly, this pattern of results was evident since the first recall and remained consistent after a period of consolidation. Although future work is needed to understand whether the preference for the gist emerges over time or immediately, our findings support the view that older adults' preference toward gist-like representations is present from the first recall and become intertwined with the transformation of memory from highly detailed to more general that naturally occurs with time and experience (e.g., Bartlett, 1995; Schacter et al., 2012; Sekeres et al., 2018). Indeed, both young and older adults recalled memories with fewer details after a week from encoding, in line with previous findings (e.g., Davis et al., 2021; Delarazan et al., 2022; Sacripante et al., 2019; Taler et al., 2021).

Overall, our findings highlighted the complexity of age-related changes in memory recall when considering the intermediate forms of declarative memory. In our studies, the inclusion of instructions to explicitly target non-episodic components of autobiographical memory, combined with the analysis of participants' narratives examining the nuances of declarative memory, revealed how a dichotomic view of declarative memory is overly simplistic to describe human recall behaviour, particularly in ageing (Greenberg & Verfaellie, 2010; Irish & Vatansever, 2020; Renoult et al., 2019; Rubin & Umanath, 2015). Indeed, our results add some nuance to the traditional finding of an episodic deficit with preserved semantic memory in ageing (e.g., Leal & Yassa, 2015; Nyberg, 1996). Understanding which processes are similar in young and older adults, for example a potential similar benefit of semantic knowledge as observed in Chapter 4 and in prior studies (e.g., Antony et al., 2022; Pitts et al., 2021), might contribute to a finer look into which specific processes may differ in ageing.

As discussed in the next section, characterising age-differences beyond a mere cognitive decline also helps in elaborating more comprehensive theories and perspectives on declarative memory.

5.3. Interpretations of age-related differences in declarative memory

As outlined in the previous chapters, there are numerous explanations for the age-related differences in declarative memory, particularly for the increased semantic production during episodic recollections in ageing. One of the primary goals of the thesis was to disentangle these interpretations by developing methodologies that manipulate retrieval instructions.

The findings from Chapter 2 of a bias towards the production of personal semantics, particularly autobiographical facts, that persisted regardless of the specific task instructions, suggest a shift in narrative style towards favoring more gist-like representations (as suggested by Grilli & Sheldon, 2022), rather than merely an episodic memory deficit or a compensatory mechanism for episodically impoverished events (e.g., Devitt et al., 2017). Older adults' increased reliance on gist-representations also emerged in Chapter 4, where despite reduced production of perceptual and contextual details compared to young adults, older adults retained and recalled the overall storyline. Furthermore, the consistency observed in participant's narratives across sessions in Chapter 4 and the consistency in the production of probed details across autobiographical interviews in Chapter 2 hint at the potential impact of trait-like tendencies in memory retrieval (for a review on individual differences in autobiographical memory, refer to Palombo et al., 2018).

Chapter 3 highlighted a role of control processes and executive functions in memory retrieval, since age-related differences emerged when task demands increased (e.g., when participants were required to switch between different retrieval modes). Several theories consider the decline in control processes as a factor contributing to age differences in recall. Older adults may rely more on the semantic components of declarative memory due to their easier accessibility in the context of a shift towards crystalized cognition, where prior personal and general knowledge acquire increased relevance (e.g., Craik & Bialystok, 2006; Spreng et al., 2018; Turner & Spreng, 2015), or due to an inhibitory decline (Amer et al., 2022). What remains unclear and would deserve further investigation is understanding when the production of gist representations and off-task recall reflects a difficulty in older adults to inhibit irrelevant information (Amer et al., 2019; Amer et al., 2022), for example due to increased task demands as in Chapter 3, and when it may reflect a deliberate choice to include additional details to tell a good story and give more context to the listener (Bluck et al., 2016; Mair et al., 2023).

5.4. Limitations and future direction

Despite our novel methodologies and compelling findings, there are methodological limitations to our work that need to be acknowledged, in addition to those mentioned within the discussion of each chapter. The limitations are discussed together with potential future investigation that may develop from our work.

The first limitation concerns the relatively small sample sizes across studies. Although power analysis revealed similarities with previous work, conducting studies with larger sample sizes are necessary to avoid underpowered studies. Given the time-consuming nature of naturalistic investigation of declarative memory, automated approaches to transcriptions and scoring (e.g., Wardell et al., 2021) as well as novel approaches to text analysis (e.g., Lee & Chen, 2022; Sheldon et al., 2023) are needed and will support the collection of larger samples.

Another potential limitation relates to the specific sample of older adults tested. The pandemic forced us to test participants at home, potentially yielding a sample that is highly functional and may not be representative of the overall population. Future research should consider addressing this potential bias by diversifying the sample. Related is the need to fully understand the impact of the testing environment on memory performance. Recent studies compared the performance of online and in-person studies revealing similar results (e.g., Giraudier et al., 2022; Hernandez et al., 2023; Sauter et al., 2022; Segen et al., 2021). However, future studies are still needed to investigate a potential beneficial effect of the home environment, particularly for older adults (Badham et al., 2022).

Expanding the battery of executive functions and cognitive control tests used is crucial, given their relevance to our interpretations. Our study did not fully disentangle all possible explanations in that regard (e.g., not including a measure of inhibition), and future research should include a more comprehensive battery of tests and explore individual differences beyond age groups and the impact of cognitive control processes during memory retrieval.

5.5. Conclusion

In this thesis, I have thoroughly examined the nuances of memory narratives generated by young and older adults in response to varying instructions. Taken together, our findings highlight the need for interpretative frameworks that transcend the traditional deficit and cognitive decline perspectives when investigating age-related changes in declarative memory retrieval. Rather than characterizing memory retrieval in ageing as cognitive decline, we, along with other researchers, support a more positive perspective that also consider what might be enriched in older adults' memory processes. The age-related differences, encompassing both narrative content and style, may indeed reflect preferences that naturally emerge during the ageing process. Our research encourages a shift in perspective, acknowledging the adaptive nature of memory in older adults.

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Appendix

Supplementary materials for Chapter 2

Detailed Instructions for the Semantic Autobiographical Interview (SAI)

Below are the detailed instructions given to participants, separately for the Personal Semantic Autobiographical Interview (P-SAI) and the General Semantic Autobiographical Interview (G-SAI). In *italics* are the verbatim instructions given to participants, while the normal text are notes for the reader to improve the understanding of the procedure.

Personal Semantic Interview Instructions

In this section, we are not interested in specific events from you past, but in general information about you. For each chapter, I will ask you to give me a brief description of that period of your life and then I am going to ask you more specific questions. I am not looking for detailed events from you past, but only for general information that describe how that chapter was like for you. For example, describing where you would usually go on holidays would be good, however, I don't need to know about a specific incident that happened on a particular day from these holidays. I do not need to hear about everything that happened during that time period, but I am interested to hear a concise overview of how that period of your life was like in general. Our interest is not so much in which facts or information you choose, but rather how you describe them. Be sure to only choose information that you feel comfortable discussing in detail. Do you have any questions?

Free Recall. *Let us start with the first chapter: if you wanted to tell someone how (life chapter title) was like for you, and you only had few minutes to give them a brief overview, what would you say?*

General Probe. At the end of the free recall, participants are given a general probe: *Is there anything else that is important to complete your brief overview of that time period?*

Specific Probing. The specific probing starts from the material that the participants spontaneously recalled in the free recall. Use this information as a base. "You said to me that you … can you tell me about other (activities, traits or facts)?". Now we are going to ask you more specific questions about the lifetime chapters that you provided. *As before, we are not interested in a detailed description of everything that happened in your life, but in a brief description of the activities you were usually doing, the kind of person you were as well as personally relevant facts.* In this section of the interview, it is important to work with the information the participant included in the Free Recall (e.g., using the information given as examples for each probe).

Repeated Events. Think of the activities you were doing regularly during (lifetime chapter): Can you briefly tell me about your weekly habits and routines? Chose a few of your frequent hobbies and tell me about those / can you tell more about your frequent hobbies at that time? Can you tell me about other relevant activities you were doing regularly over these years? The researcher should ask each question separately.

Self-Knowledge. Think of the kind of person you were during (lifetime chapter): Which personality traits and character best described you? Did you have particular *opinions and beliefs at that time? (e.g., related to the world, your personality or your goals at the time) Were there particular things that you liked and loved? (e.g., preferences and tastes).* The researcher should ask each question separately.

Autobiographical Facts. Think of personally relevant facts that characterized your (lifetime period): Which personally relevant facts would you include to create a skeleton of your biography in that period? (here, it is important to work with the facts that the participant included in the free recall) If participants are not sure about the meaning of "facts", we can rephrase the probe (e.g., which personal information or important events would you include to describe those years). *Who are the most relevant people you were interacting with during this period (friends, family, colleagues, and teachers)? Which places were most relevant to you in that period? You can think of places where you lived/studied/worked.* The researcher should ask each question separately.

General Semantic Interview Instructions

Now we will do something different. Instead of asking information about yourself and your personal past, I am going to ask you about the public events that defined the last year. You could think of public events in your environment and social context, such as politics or culture (film, music, and fashion), as well as relevant famous people at that time. Do you have any questions?

Free Recall. *If you wanted to tell someone what was going on in your community, your country or internationally, during the last year, and you only had few minutes to give a brief overview, what would you say?*

General Probing. *Is there anything else that is important to complete your brief overview for the last year?*

Specific Probing. *Now I am going to ask you more specific questions about the world knowledge you have for that time. As before, I am not interested in a detailed description of everything that happened in the world, but by a brief description of the information you think is mostly relevant. Can you tell me about: Public events that happened during that time (things that were in the news) in your community or in the world; Famous public figures during that time in your community or in the world; Trends and things that were popular in your community or in the world at that time (e.g., films, music, fashion)?* The researcher should ask each question separately.

Supplementary Results

Age Differences in the Detail Counts Across Interviews – Cumulative Recall

The focus of the analysis on the main text was the proportion of detail on total details, to control for older adults consistently providing overall more details in the AI and P-SAI (though this difference was not significant in the G-SAI). For transparency we decided to include details count as supplementary material, as they could also guide the reader in interpreting our results.

Autobiographical Interview. We first explored age differences for the production of the different detail types in the cumulative recall of the Autobiographical Interview. The ANOVA including all details subtypes revealed a main effect of detail type ($F(6,329) = 272.31$, $p < 0.001$, $\eta p2 = 0.83$, 95% CI [0.81, 1.00]), a significant main effect of age group (F(1,329) = 18.27, p < 0.001, ηp2 = 0.05, 95% CI [0.02, 1.00]), and a significant detail type x group interaction (F(6,239) = 3.88, p < 0.001, ηp2 = 0.07, 95% CI [0.02, 1.00]). Older adults' recollection of unique events included more episodic details (U = 430, p = 0.01, rg = 0.43, 95% CI [6.00, 32.50]), but also more autobiographical facts (U = 493, p < 0.001, rg = 0.64, 95% CI [3.00, 8.50]), self-knowledge (U = 462, p = 0.001, rg = 0.54, 95% CI [0.50, 2.00]), repeated events (U = 414, p = 0.02, rg = 0.38, 95% CI [0.0005, 1.00]), and general semantic details (U = 430, p = 0.01, rg = 0.43, 95% CI [0.50, 3.50]), compared to younger adults (see **Figure S.1** and **Table S.1** for median values), while no difference was found for repetitions and "other" detail types (all *p-values* > 0.09).

Personal Semantic Interview. We then considered age differences for the production of the different detail types in the cumulative recall of the Personal Semantic Interview. The ANOVA revealed a main effect of detail type (F(6,329) = 169.12, p < 0.001, ηp2 = 0.76, 95% CI [0.72, 1.00]), a significant main effect of age group (F(1,329) = 50.02, p < 0.001, ηp2 = 0.13, 95% CI [0.08, 1.00]), and a significant detail type x group interaction (F(6,239) = 18.08, p < .001, ηp2 = 0.25, 95% CI [0.18, 1.00]). Older adults' memories included more autobiographical facts (U = *530,* p < 0.001, rg = 0.77, 95% CI [25.50, 53.20]), but also more off-task recall such as episodic details (U = *482,* p < 0.001, rg = 0.61, 95% CI [0.25, 3.00]), and general semantic details (U = *477,* p < 0.001, rg = 0.59, 95% CI [1.50, 6.69]), compared to younger adults (see **Figure S.1** and **Table S.1** for median values), while no difference was found for self-knowledge, repeated events, repetitions and "other" detail types (all *p-values* > 0.05).

General Semantic Interview. Finally, we analysed the age differences for the production of the different detail types in the cumulative recall of the General Semantic Interview. The ANOVA revealed a main effect of detail type ($F(6,329) = 129.06$, $p < 0.001$, ηp2 = 0.70, 95% CI [0.66, 1.00]), a significant main effect of age group ($F(1,329) = 20.49$, $p < 0.001$, ηp2 = 0.06, 95% CI [0.02, 1.00]), and a significant detail type x group interaction ($F(6,239) = 3.61$, $p = 0.002$, ηp2 = 0.06, 95% CI [0.01, 1.00]). Older adults' recollections included more off-task recall and in particular more self-knowledge ($U = 520$, $p < 0.001$, *rg* = 0.73, 95% CI [6.00, 14.00]), more autobiographical facts ($U = 462$, $p = 0.001$, *rg* = 0.54, 95% CI [1.00, 6.00]), but also more repetitions ($U = 436$, $p = 0.006$, *rg* = 0.45, 95% CI [1.00, 3.00]) than young adults (see **Figure S.1** and **Table S.1** for median values), while no difference was found in the production of general semantic, repeated events, episodic and "other" detail types (all *p-values* > 0.13).

Table S. 1. Counts of cumulative details in young and older adults in the AI, P-SAI and G-SAI

	AI			P-SAI			G-SAI		
	OA	YA	p-value	OA	YA	p-value	OA	YA	p-value
Episodic	**72**	**48.9**	**0.01***	1.22	0	<0.001*	1.34	0.037	0.18
AF	9.75	3.5	<0.001*	**9**	**6.35**	**<0.001***	6.71	3.01	0.004*
SK	2.25	0.5	0.001*	**5.59**	**5.12**	**0.33**	16.20	5.90	< 0.001*
RE	0.5	0	0.02*	**4.64**	**3.97**	**0.03***	0.63	0.15	0.18
GS	2.5	1	0.01*	2.55	1.32	<0.001*	**33.10**	**28.5**	**0.29**
Repetitions	9	6.88	0.09	3.74	3.20	0.34	4.11	2.10	0.15*
Other	9	7.25	0.14	3.74	3.32	0.23	9.97	9.72	0.76

Notes. Median values are reported for young and older adults together with the p-value corrected for multiple comparisons. The values in bold are the targets details in each interview. AI = Autobiographical Interview. P-SAI: Personal Semantic Interview. G-SAI: General Semantic Interview. AF = Autobiographical Facts. SK = Self-Knowledge. RE = Repeated Events. GS = General Semantic. OA = Older adults. YA = Young adults. * refers to significant group differences

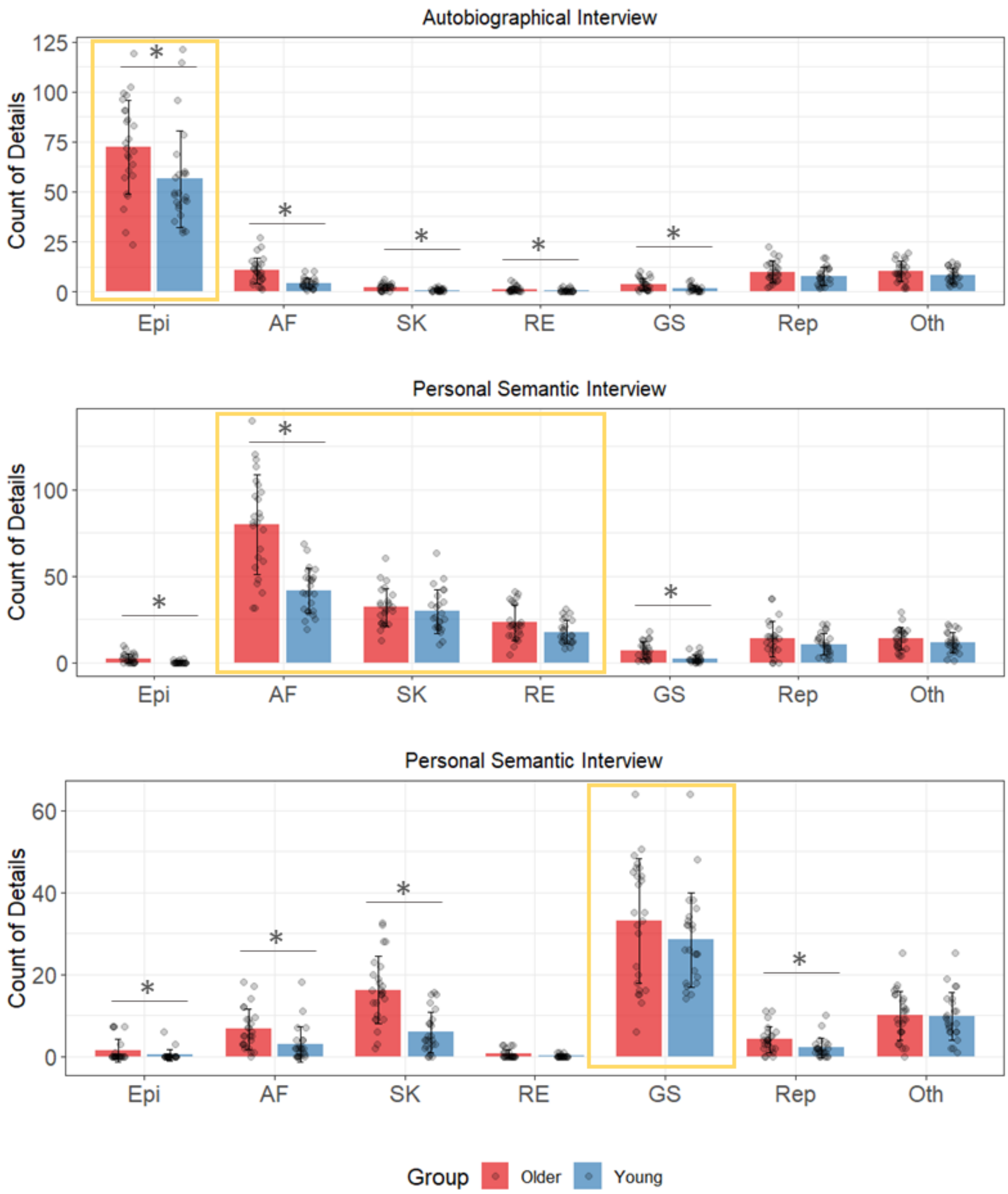

Figure S. 1. Bar plots referring to details count in cumulative recall for young and older adults for the Autobiographical Interview, Personal Semantic Interview and General Semantic Interview. Dots represent individual subjects. Error bars refer to standard deviation of the mean. The yellow box refers to the target details. Epi = episodic. AF = autobiographical facts. SK = self-knowledge. RE = repeated events. GS = general semantic. Rep = repetitions. Oth = other detail types.

Age Differences in the Detail Counts Across Interviews – Spontaneous Recall

Here the focus will be on the spontaneous recall, thus including in the analysis the details produced during the free recall and general probe sections of the AI, P-SAI and G-SAI.

Autobiographical Interview. The ANOVA including all details subtypes revealed a main effect of detail type ($F(6,329) = 195.52$, $p < 0.001$, $\eta p2 = 0.78$, 95% CI [0.75, 1.00]), a significant main effect of age group ($F(1,329) = 10.79$, $p < 0.001$, $\eta p2 = 0.03$, 95% CI [0.01, 1.00]), with older adults including overall more details (*Mdn* = 2.98) than young adults (*Mdn* = 1.5), but no significant detail type x group interaction ($p = 0.11$). Participants' recollection of unique events were richer in episodic details (*Mdn:* 37.2) than all the other detail types (all *p-values* < 0.001), then richer in autobiographical facts (*Mdn* = 4.5; all *p-values* < 0.001) and "other" types of details (*Mdn* = 4.25; all *p-values* < 0.001) but with no difference between these details ($p = 0.7$). Narratives were also richer in repetitions (*Mdn:* 2) than the other forms of semantic details (all *p-values* < 0.001). Finally, participants recalled more general semantic (*Mdn:* 1) than self-knowledge (*Mdn:* 0.5) and repeated events (*Mdn:* 0; all *p-values* < 0.001; See **Figure S.2** and **Table S.2** for median values and plots.

Personal Semantic Interview. We then considered age differences for the production of the different detail types in the spontaneous recall of the P-SAI. The ANOVA revealed a main effect of detail type ($F(6,329) = 107.46$, $p < 0.001$, $\eta p2 = 0.66$, 95% CI [0.62, 1.00]), a significant main effect of age group ($F(1,329) = 29.69$, $p < 0.001$, $\eta p2 = 0.08$, 95% CI [0.04, 1.00]), and a significant detail type x group interaction

(F(6,239) = 15.13, p < .001, ηp2 = 0.22, 95% CI [0.14, 1.00]). Older adults' memories included more autobiographical facts (U = *484,* p = 0.001, *rg* = 0.61, 95% CI [6.0, 18.0]), and more repeated events (U = *456,* p = 0.004, *rg* = 0.52, 95% CI [0.5, 3.0]), but also more off-task recall such as episodic details (U = *384,* p = 0.01, *rg* = 0.28, 95% CI [0, 0.05]), and general semantic details (U = *471,* p = 0.002, *rg* = 0.57, 95% CI [0.5, 1.75]), compared to younger adults (see **Figure S.2** and **Table S.2** for median values), while no difference was found for self-knowledge, repetitions and "other" detail types (all *p-values* > 0.64).

General Semantic Interview. Finally, we analysed the age differences for the production of the different detail types in the spontaneous recall of the G-SAI. The ANOVA revealed a main effect of detail type (F(6,329) = 81.76, p < 0.001, ηp2 = 0.60, 95% CI [0.54, 1.00]), no main effect of age group (p = 0.23) a significant detail type x group interaction (F(6,239) = 6.22, p < 0.001, ηp2 = 0.10, 95% CI [0.04, 1.00]). Older adults' general semantic recollections only included more self-knowledge information than young adults (U = 520, p < 0.001, *rg* = 0.73, 95% CI [6.00, 14.00]; see **Figure S.2** and **Table S.2** for median values), while no difference was found in the production of all other types of details (all *p-values* > 0.17).

Table S. 2. Counts of spontaneous details in young and older adults in the AI, P-SAI and G-SAI

	AI			P-SAI			G-SAI		
	OA	YA	p-value	OA	YA	p-value	OA	YA	p-value
Episodic	**44.0**	**30.8**	**-**	0	0	0.01*	0	0	0.63
AF	7.2	2.0	-	**24.8**	**9.25**	**0.001***	1.5	0.25	0.25
SK	1.5	0.25	-	**5.5**	**5.5**	**0.75**	16.20	5.90	0.003*
RE	0.5	0	-	**2.0**	**0.5**	**0.004***	0.63	0	0.20
GS	1.5	0.25	-	1.75	0.5	0.002*	**8.0**	**11.5**	**0.29**
Repetitions	0	3.0	-	1.75	1.5	0.91	4.11	0	0.47
Other	5.5	3.5	-	2.0	1.62	0.64	2.0	3.0	0.17

Notes. Median values are reported for young and older adults together with the p-value corrected for multiple comparisons. The values in bold are the targets details in each interview. AI = Autobiographical Interview. P-SAI: Personal Semantic Interview. G-SAI: General Semantic Interview. AF = Autobiographical Facts. SK = Self-Knowledge. RE = Repeated Events. GS = General Semantic. OA = Older adults. YA = Young adults. * refers to significant group differences

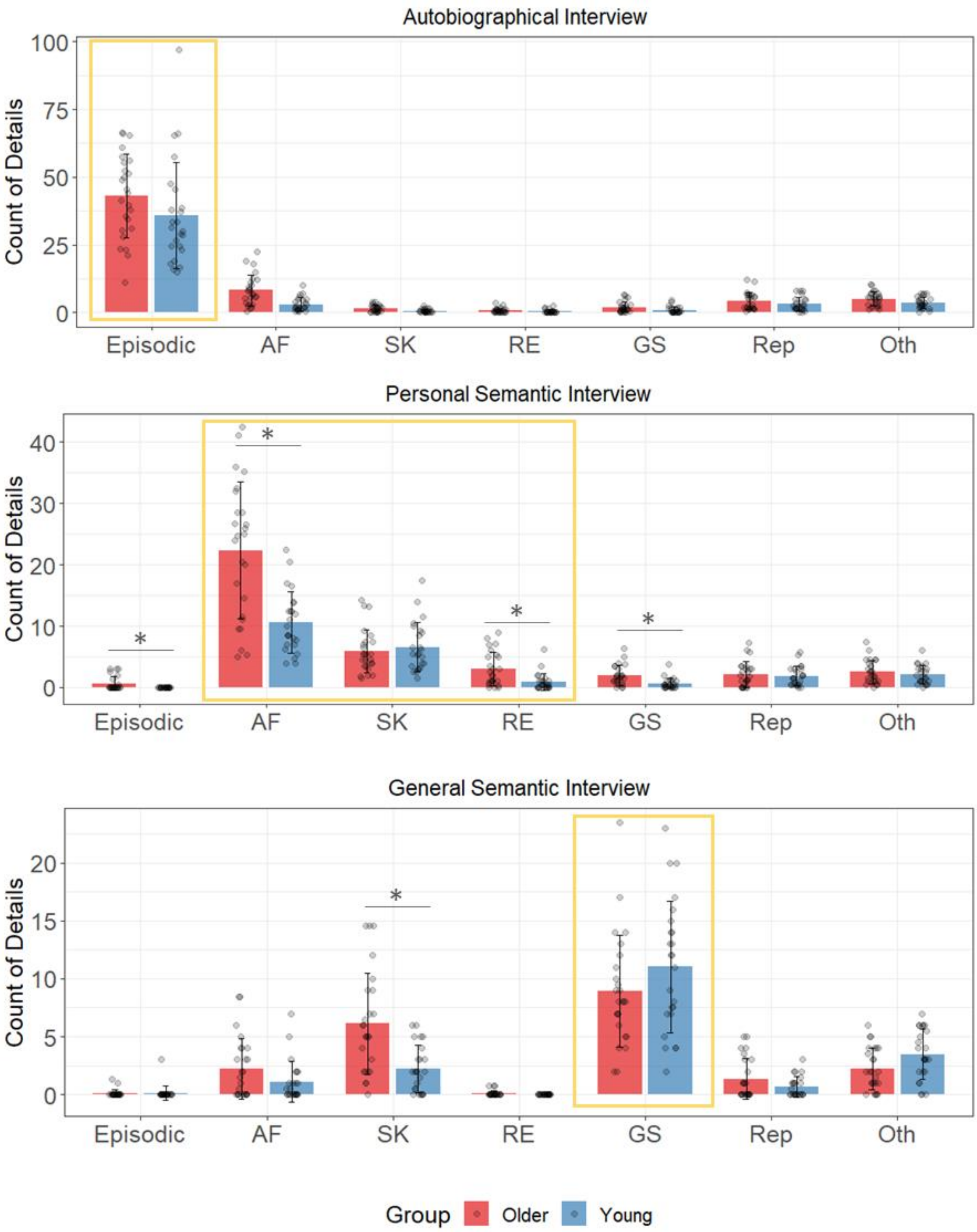

Figure S. 2. Bar plots referring to details count in spontaneous recall for young and older adults for the Autobiographical Interview, Personal Semantic Interview and General Semantic Interview. Dots represent individual subjects. Error bars refer to standard deviation of the mean. The yellow box refers to the target details. Epi = episodic. AF = autobiographical facts. SK = self-knowledge. RE = repeated events. GS = general semantic. Rep = repetitions. Oth = other detail types.

Age Differences in the Proportion of Details Recalled – Spontaneous Recall Phase

Here we looked at the spontaneous recall, thus only including in the analysis the proportion of details produced in the free recall and general probe sections of the AI, P-SAI and G-SAI.

Autobiographical Interview. Considering the production of the different sub-type of details in young and older adults narratives, the ANOVA revealed a main effect of detail type ($F(6,329) = 1066.73$, $p < 0.001$, ηp2 = 0.95, 95% CI [0.94, 1.00]), and a significant detail type x group interaction ($F(6,329)$ 8.16, $p < 0.001$, ηp2 = 0.13, 95% CI [0.07, 1.00]), but no main effect of group ($p > 0.98$). Post hoc analysis indicated that older adults' episodic recollections included a higher proportion of autobiographical facts (AF), but a lower proportion of episodic details compared to young adults (AF: $U = 467$, $p =$ 0.006, $rg = 0.56$, 95% CI [0.02, 0.09]; episodic: $U = 174$, $p =$0 .04, $rg = -0.42$, 95% CI [-0.15, -0.02]; see **Figure S.3** and **Table S.3** for median values).

Personal Semantic Interview. We next analysed the production of details in the P-SAI spontaneous recall. The analysis on group differences revealed a main effect of detail type ($F(6,329) = 303.53$, $p < 0.001$, ηp2 = 0.85, 95% CI [0.83, 1.00]), and a detail x age group interaction ($F(6,329) = 9.8$, $p < 0.001$, ηp2 = 0.15, 95% CI [0.09, 1.00]), but no main effect of group ($p > 0.98$). The differences between age groups were driven by higher proportion of autobiographical facts (AF), general semantic (GS), repeated events (RE) and episodic details, but a lower proportion of self-knowledge details in older adults (SK), compared to young adults (AF: $U = 418$, $p = 0.03$, $rg = 0.39$, 95% CI [0.01, 0.15]; GS: $U = 424$, $p = 0.03$, $rg = .41$, 95% CI [0.003, 0.04]; RE: $U = 417$, $p = 0.03$, $rg = .39$, 95% CI [0.003, 0.05]; episodic: *U = 384, p* = 0.02, *rg* = 0.28, 95% CI [0.00, 0.0001]; SK: *U = 127, p* = 0.003, *rg* = -0.58, 95% CI [-0.20, -0.06]; see **Figure S.3** and **Table S.3** for median values). To be noted here is that no young adults' participants spontaneously included episodic details in their narratives, and only seven older adults had episodic information in their narratives.

General Semantic Interview. The analysis on the proportion of details types in the G-SAI for the free recall and general probe phases revealed a main effect of detail type ($F(6,329) = 144.24$, $p < 0.001$, ηp2 = 0.72, 95% CI [0.69, 1.00]), and a significant interaction between age group and detail type ($F(6,329) = 13.24$, $p < 0.001$, ηp2 = 0.19, 95% CI [0.12, 1.00]), but no main effect of group ($p > 0.98$). The narratives of older adults included higher ratio of self-knowledge details (SK) as well as a lower proportion of general semantic (GS) and "other" type of details, compared to younger adults narratives (SK: *U = 482, p* = 0.002, *rg* = .61, 95% CI [0.08, 0.27]; GS: *U = 145, p* = 0.007, *rg* = -0.52, 95% CI [-0.25, -0.05]; "other": *U = 166, p* = 0.02, *rg* = -0.44, 95% CI [-0.17, -0.02]; see **Figure S.3** and **Table S.3** for median values).

Table S. 3. Proportion of detail types in young and older adults for spontaneous recall (free recall and general probe) in the AI, P-SAI and G-SAI

	AI			P-SAI			G-SAI		
	OA	YA	p-value	OA	YA	p-value	OA	YA	p-value
Episodic	**0.67**	**0.76**	**0.04***	0	0	0.02*	0	0	0.76
AF	0.12	0.06	<0.001*	**0.56**	**0.49**	**0.03***	0.07	0.02	0.12
SK	0.03	0.01	0.001*	**0.13**	**0.32**	**0.003***	0.27	0.09	< 0.001*
RE	0.01	0.01	0.02*	**0.05**	**0.02**	**0.03***	0	0	0.17
GS	0.03	0.02	0.01*	0.04	0.02	0.03*	**0.43**	**0.58**	**0.006***
Repetitions	0.06	0.06	0.09	0.05	0.07	0.23	0	0	0.22
Other	0.08	0.08	0.14	0.05	0.10	0.15	0.09	0.20	0.01*

Notes. Median values are reported for young and older adults together with the p-value corrected for multiple comparisons. The values in bold are the targets details in each interview. AI = Autobiographical Interview. P-SAI: Personal Semantic Interview. G-SAI: General Semantic Interview. AF = Autobiographical Facts. SK = Self-Knowledge. RE = Repeated Events. GS = General Semantic. OA = Older adults. YA = Young adults. * refers to significant group differences

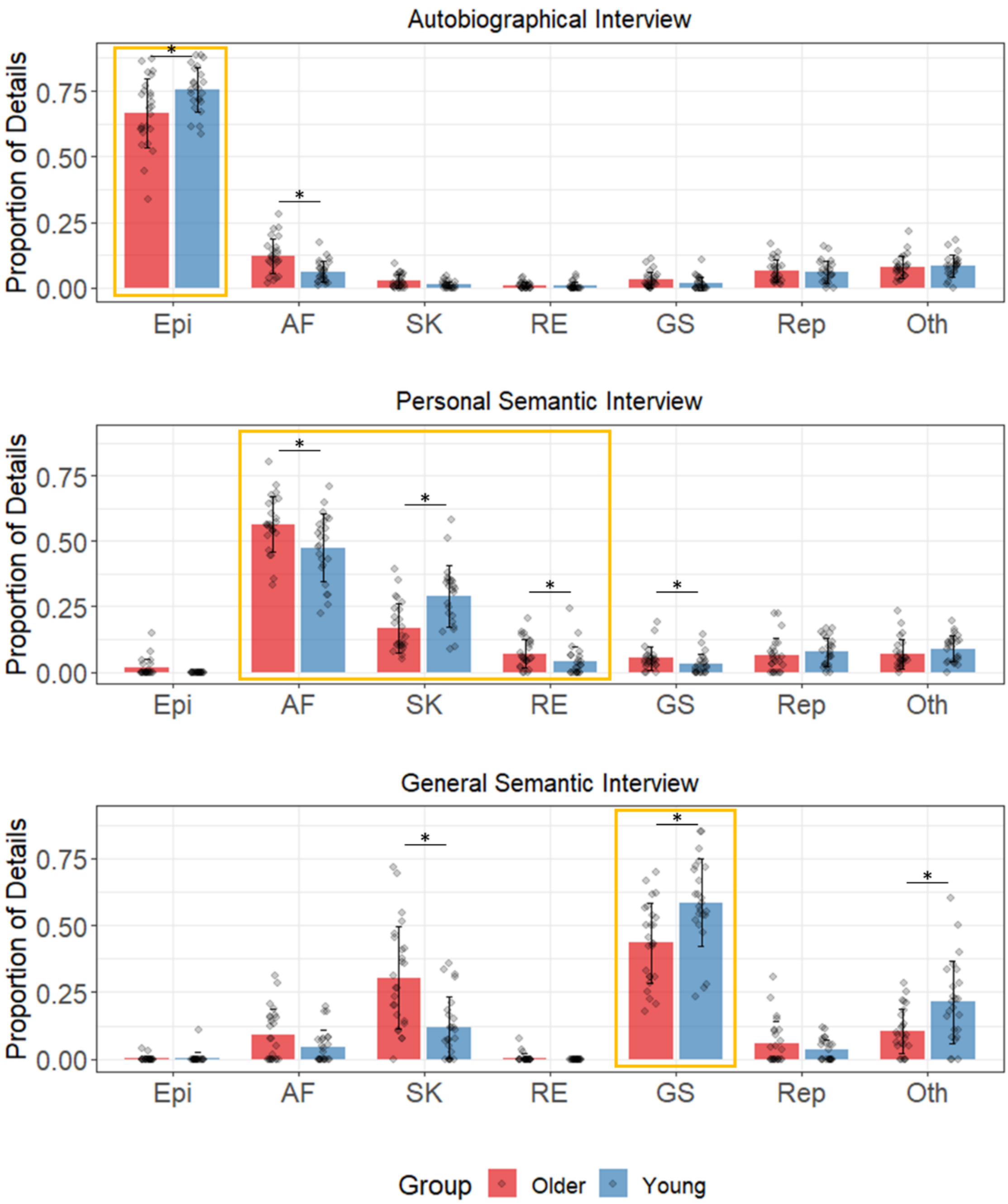

Figure S. 3. Bar plots referring to details proportions in spontaneous recall for young and older adults for the Autobiographical Interview, Personal Semantic Interview and General Semantic Interview. Dots represent individual subjects. The yellow box refers to the target details. Epi: Episodic. AF: Autobiographical Facts. SK: Self-Knowledge. RE: Repeated Events. GS: General Semantic. Rep: Repetitions. Oth: Other details.

Supplementary materials for Chapter 3

Table S. 4. List of words used, with imageability, concreteness, frequency emotional valence values.

Word	Img	Con	Frqtl	Emo
Apple	6,7	7,0	1,7	1,9
Book	6,4	7,0	2,0	2,5
Building	6,4	6,9	2,0	2,8
Cat	6,8	7,0	2,0	3,7
Chair	6,6	7,0	2,0	2,0
Coffee	6,7	6,9	1,7	3,3
Fire	6,7	6,7	2,0	4,9
Flower	6,6	7,0	2,0	3,6
Friend	6,4	4,9	2,0	5,5
Garden	6,7	6,8	2,0	3,3
Gift	5,8	6,0	1,7	5,3
Library	6,7	6,9	1,7	2,8
Market	6,1	6,1	2,0	2,4
Party	6,3	5,5	2,0	5,3
River	6,6	6,8	2,0	3,5
Sea	6,7	6,8	2,0	4,1
Shoes	6,6	7,0	2,0	2,5
Speech	4,3	4,9	2,0	3,4
Ticket	6,2	7,0	1,7	3,3
Tool	5,8	6,8	1,6	2,5
Tree	6,8	7,0	2,0	2,1

Note. Values are from Clark & Paivio, 2004. Img = imageability. Con = concreteness. Frqtl = Thorndike-Lorge frequency. Emo = emotional valence.

Consistency with instructions scoring

Each memory was categorized following the AMT scoring (Williams & Broadbent, 1986), as one of the following: (1) *Specific*: episodic memory, unique event that lasted less than a day; (2) *Categoric*: repeated event, events that happened multiple time in the past in a similar way; (3) *Extended*: event that lasted longer than a day; (4) *Semantic associate*: not an event, but personal or general semantic information (e.g. personal facts or self-knowledge). (5) *Omission*: no memory has been recalled. Below are examples of specific and categoric memories.

Examples of consistency scoring

SPECIFIC – "I really like hazelnut flavoured coffee and I remember going to the shop because I'd run out and picking up a bag of hazelnut flavoured coffee and, when I got home, it wasn't hazelnut flavoured at all it was caramel which I didn't like at all so I was disappointed."

SPECIFIC – "I remember one river which was when I was on holiday about 10 years ago. I was climbing on lots of rocks and I ended up slipping and cutting my hand on the edge of the rock."

CATEGORIC – "I lived in a village that is next to a river, and we don't go anywhere else expect the river when you go through this village, so I take the dog for a walk to the river most days and when my children and grandchildren are here, I walk there with them so this river is very much a big part of my life."

CATEGORIC – "Every summer in my family home, we always have barbecues, we have lots of people over and this is always out in our garden; this is like a yearly events we've done it for the last five years maybe always out in the garden."

Details scoring

Each detail was scored following an adaptation of the scoring scheme from Levine and colleagues (2002) as one of the following: (1) *Episodic* (EV): detail about the unfolding of the event (including perceptual, spatial-temporal and emotional information); (2) *Repeated Event* (RE): detail about a repeated event, including perceptual, spatial-temporal and emotional information; (3) *Semantic* (SEM): general and personal semantic information (including autobiographical facts and self-knowledge information); (4) *Other* (OTH): repetition and metacognitive statement. Below are examples of detail scoring.

Examples of detail scoring

"When I was younger before we had central heating in the winter SEM we would have a we would have to get dressed in front of the fire every morning RE my brother and I and RE we used to try and push each other away RE so that we could get the closest to it RE"

"I like going to markets SEM, but I specifically remember going to a fish market in PLACE EV That's many, many years ago now EV, but the variety of fish EV and all the colourful fruit smoothies EV was absolutely incredible EV"

"I was sat in my garden EV a few weeks ago EV it is one of my favourite activities SEM and there was a cat, the neighbours cat that came up to us EV and I was sat on my back door step EV and it came up to me EV and let me pet it EV."

"I don't know if this counts, so I apologize OTH, but every time I look at the see from the beach RE I get a great fear out of it RE but also calmness RE and I usually sit on the sand and look at it RE I don't really have much memories connected to the sea I apologize OTH"

Statistical analysis for comparing switch and remain trials

We compared the performance in the switching block between switch (after a change in instructions) and remain trials (after a trial with the same retrieval instructions). We ran an ANOVA with trial type (2; switch and remain), group (2; young and older adults) and retrieval instruction (2; specific and categoric) as factors. We then ran a mixed ANOVA on the proportions of details with trial type (2; switch and remain), detail (4; episodic, categoric, semantic and other) and retrieval instruction (2; categoric and specific) as within-subjects factors, while group as between factor. Finally, subjective ratings of vividness, perspective, emotion and time location were analysed at a trial level. We ran ANOVAs with trial (2; switch vs remain), retrieval instruction (2; categoric and specific) as within-subjects factors, and with age group (2; young and older adults) as a between-subjects factor. Analysis of time ratings followed the same structure but separately for specific and categoric instructions, as the ratings were different for specific (4; last year, within five years, from 5 to 10 years ago, and more than 10 years ago) and categoric memories (5; last year, within five years, from 5 to 10 years ago, more than 10 years ago and across the life course).

Supplementary results comparing switch and remain trials

Overall recall performance

Table S.5 reports the descriptive values of the types of memories (specific, categoric, semantic associates or extended events) that participants recalled in response to specific and categoric instructions, separate for and remain trials of the switching block, respectively. Overall, participants were able to follow instructions, as participants tended to recall specific events under specific instructions and categoric memories under categoric instructions, although older adults presented more difficulties in reporting categoric memories, particularly in the switching block.

Table S. 5. Mean values (standard deviation) of memories recalled in the switch and remain trials of the switching block, separate for specific and categoric instructions.

	Switch trials				**Remain trials**			
	Specific		**Categoric**		**Specific**		**Categoric**	
	OA	**YA**	**OA**	**YA**	**OA**	**YA**	**OA**	**YA**
Specific	**0.74 (0.26)**	**0.86 (0.19)**	0.02 (0.05)	0.01 (0.03)	**0.78 (0.24)**	**0.86 (0.19)**	0.02 (0.05)	0.01 (0.04)
Extended Event	0.04 (0.07)	0.01 (0.04)	0.01 (0.04)	0 (0)	0.05 (0.07)	0.01 (0.03)	0.003 (0.02)	0 (0)
Categoric	0.01 (0.04)	0.02 (0.05)	**0.53 (0.33)**	**0.79 (0.29)**	0 (0)	0 (0)	**0.67 (0.32)**	**0.77 (0.29)**
Semantic Associate	0.02 (0.05)	0.01 (0.04)	0.10 (0.09)	0.06 (0.08)	0.05 (0.06)	0.01 (0.04)	0.12 (0.10)	0.07 (0.09)
Omissions	0 (0)	0 (0)	0.01 (0.03)	0.003 (0.02)	0.02 (0.04)	0.01 (0.03)	0.003 (0.02	0.01 (0.04)

Impact of switch costs on recall consistency with instructions

The ANOVA revealed a main effect of group ($F(1,228) = 16.04$, $p < 0.001$), with older adults recalling a lower proportion of memories coherent with instructions ($Mdn = 0.68$) than young adults ($Mdn = 0.82$), and main effect of retrieval instructions ($F(1,228) = 12.0$, $p < 0.001$), with participants recalling a higher proportion of specific memories coherent with instructions (*Mdn* = 0.81) than categoric memories (*Mdn* = 0.69), while the main effect of trial type (remain vs. switch) did not reach a significant level (p = 0.26), nor did the other interactions (all *p-values* > 0.14; see **Figure S.4**). Consistent with our hypothesis, age-related differences did not emerge when looking at a trial level, comparing switch and remain trials.

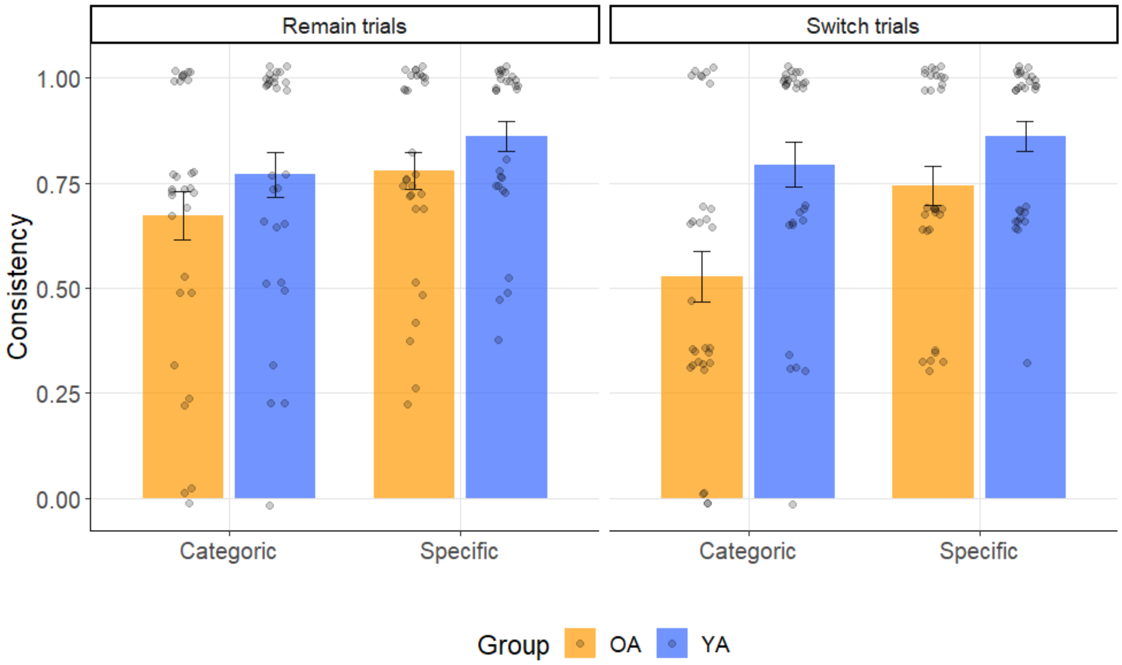

Figure S. 4. Retrieval consistency with instructions on switch and remain trials in young and older adults. The plot represents the proportion of memories recalled coherent with instructions The mean values are shown within the standard error bars. Points refer to individual data points. OA = Older adults. YA = Younger adults.

Impact of switch costs on the proportion of details produced according to instructions

We then looked for differences in participants narratives comparing switch and remain trials within the switching block. The ANOVA revealed a main effect of detail (F(1,912) = 157.35, p < .001, ηp2 = 0.34, 95% CI [0.30, 1.00]), a significant detail x group interaction (F(1,912) = 39.28, p < .001, ηp2 = 0.11, 95% CI [0.08, 1.00]), a significant detail x retrieval instruction interaction (F(1,912) = 533.12, p < .001, ηp2 = 0.64, 95% CI [0.61, 1.00]) as well a significant group x detail x retrieval instruction interaction (F(1,912) = 16.83, p < 0.001, ηp2 = 0.05, 95% CI [0.03, 1.00]). The main effect of trial type, group and retrieval instruction were not significant (*p-values* > 0.80), nor were the interactions between these factors (all *p-values* > 0.24; See **Figure S.5**). Post-hoc comparisons on the detail x group interaction revealed that older adults recalled a higher proportion of semantic details than young adults (*Mdn* = 0.31 vs. 0.13 for older vs. young, U = 10536, p < 0.001, 95% CI [0.14, 0.21]), while no difference was found for the other type types of details (all *p-values* > 0.17). Post-hoc comparisons on the retrieval instruction x detail interaction revealed that narratives probed by specific instructions were characterised by a higher proportion of episodic details than categoric memories (*Mdn* = 0.69 vs. 0 for older vs. young, U = 265, p < 0.001, 95% CI [-0.69, -0.62]), showing how participants were able to follow instructions, while narratives probed by categoric instructions were characterised by a higher proportion of repeated events details than specific instructions (*Mdn* = 0.50 vs. 0 for older vs. young, U = 13182, p < 0.001, 95% CI [0.39, 0.50]), as well as more semantic details (*Mdn* = 0.33 vs. 0.21 for older vs. young, U = 9922, p < 0.001, 95% CI [0.10, -0.21]), showing how participants were able to follow instructions but still included semantic information under more general instructions.

Given that participants elaborated upon specific and categoric memories differentially, we investigated the group x detail x retrieval instructions interaction by running two separate ANOVAs on detail production for memories retrieved under specific and categoric instructions. The ANOVA on details recalled when probed by specific instructions revealed a main effect of detail (*F*(1,228) = 635.01, $p < .001$, ηp2 = 0.89, 95% CI [0.87, 1.00]), a significant detail x group interaction (*F*(1,228) = 15.52, $p < .001$, ηp2 = 0.17, 95% CI [0.10, 1.00]), while the main effect of group was not significant ($p =$ 0.89). Post-hoc comparisons revealed that older adults recalled a lower proportion of episodic details than young adults (*Mdn* = 0.67 vs. 0.80 for older vs. young, *U* = 235*,* $p =$ 0.002, 95% CI [-0.20, -0.05]), but a higher proportion of semantic details (*Mdn* = 0.22 vs. 0.07 for older vs. young, *U* = 718*,* $p < 0.001$, 95% CI [0.01, 0.17]), while no difference was found in the proportion of repeated events and "other" types of details (all *p-values* > 0.46; See **Figure S.5**). The ANOVA on details recalled when probed by categoric instructions revealed a main effect of detail (*F*(1,228) = 153.37, $p < .001$, ηp2 = 0.67, 95% CI [0.61, 1.00]), a significant detail x group interaction (*F*(1,228) = 23.07, $p < .001$, ηp2 = 0.23, 95% CI [0.15, 1.00]), while the main effect of group was not significant ($p =$ 0.89). Post-hoc comparisons revealed that older adults recalled a lower proportion of target repeated event details than young adults (*Mdn* = 0.41 vs. 0.71 for older vs. young, *U* = 183, $p < 0.001$, 95% CI [-0.34, -0.13]) but a higher proportion of semantic details (*Mdn* = 0.42 vs. 0.21 for older vs. young, *U* = 746*,* $p < 0.001$, 95% CI [0.14, 0.29]), while no difference was found in the proportion of episodic and "other" types of details (all *p-values* > 0.43; See **Figure S.5**). In summary, consistent with our hypothesis, we found no switch costs on details productions when comparing switch and remain trials. =lder adults produced a higher proportion of semantic details than young adults, together with a lower proportion of details coherent with instructions (episodic details under specific instructions and repeated events under categoric instructions).

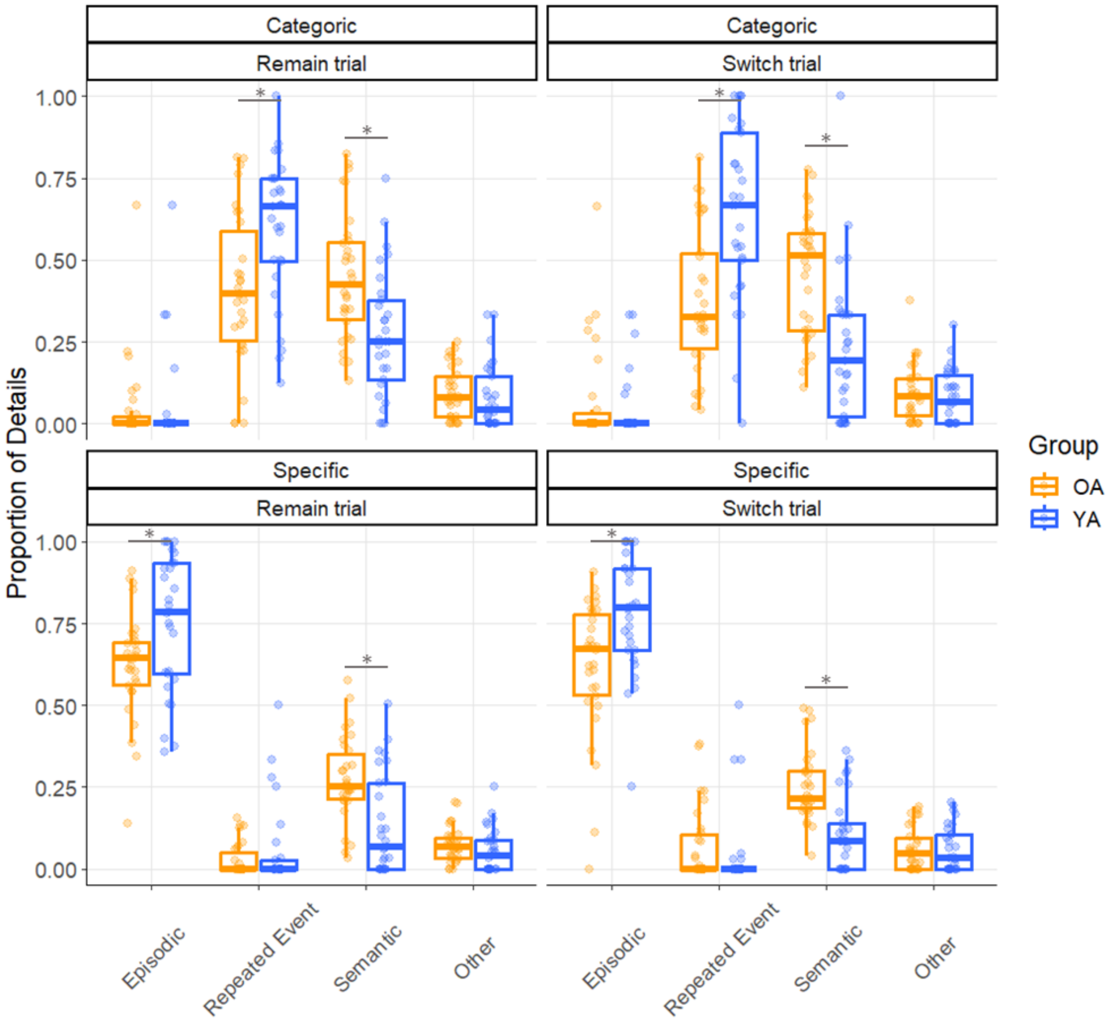

Figure S. 5. Box plot for proportion of details in young and older adults, separate for specific (episodic) and categoric (repeated event) memories. Proportion of details refers to the proportion of details type on total details. OA = Older adults. YA = Younger adults. Standard error bars are shown in the plot. * refers to significant difference between YA and OA.

Subjective ratings separate for switch and remain trials

Vividness ratings. The mixed ANOVA on vividness ratings revealed a main effect of retrieval instructions ($F(1,228) = 24.73$, $p < .001$, ηp2 = 0.10, 95% CI [0.05, 1.00]), a main effect of group ($F(1,228) = 27.85$, $p < .001$, ηp2 = 0.11, 95% CI [0.05, 1.00]), and an interaction between group and retrieval instructions (*F*(1,228) = 4.10, $p = 0.04$, ηp2 = 0.02, 95% CI [0.00, 1.00]), but no main effect of trial, nor any additional interactions (all *p-values* > 0.20). Post-hoc comparisons showed that older adults' memories were rated as more vivid than young adults', both under specific instructions (*Mdn* = 4.00 vs 3.50, *U* = 2171, $p = 0.02$, 95% CI [0.001, 0.67]), and categoric instructions (*Mdn* = 3.67 vs 2.88, *U* = 2565.5, $p < 0.001$, 95% CI [0.42, 1.00]).

Perspective ratings. The mixed ANOVA on perspective ratings did not reveal main effects of group, trial, or retrieval instructions, nor interactions between these factors (all *p-values* > 0.21).

Emotion ratings. The ANOVA on emotion ratings revealed a main effect of retrieval instructions (*F*(1,228) = 19.86, $p < .001$, ηp2 = 0.08, 95% CI [0.03, 1.00]), with memories retrieved under specific instructions judged as more emotional than those under categoric instructions (*Mdn* = 3.00 vs 2.42), and a main effect of group (*F*(1,228) = 4.86, $p = 0.03$, ηp2 = 0.02, 95% CI [0.00, 1.00]), with older adults rating memories as more emotional than young adults (*Mdn* = 2.25 vs 2.00), but no main effect of block nor interaction with other factors (all *p-values* > 0.07).

Temporal ratings. We then looked at the temporal location of the events recalled, separate for categoric and specific retrieval instructions, in the switch and remain trials. The mixed ANOVA on the subjective temporal ratings for categoric instructions revealed a main effect of time of events (*F*(4,570) = 21.48, $p < .001$, ηp2 = 0.13, 95% CI [0.09, 1.00]), a significant interaction between time and group (*F*(4,570) = 4.76, $p < 0.001$, ηp2 = 0.03, 95% CI [0.01, 1.00]), while no main effect of group and block were found, nor any additional interactions between these factors (all *p-values* > 0.06). Follow-up analysis on the time of events x group interaction revealed that older adults recalled fewer memories from the last year than young adults (*Mdn = 0.14 vs 0.32 for older vs young,* *U* = 1256*, p* = 0.004, 95% CI [-0.25, -0.001]; See **Figure S.6B**). The mixed ANOVA on the subjective temporal ratings under specific instructions revealed a main effect of time of events (*F*(4,456) = 13.36, $p < .001$, ηp2 = 0.08, 95% CI [0.04, 1.00]), and a significant interaction between time and group (*F*(4,456) = 44.00, $p < 0.001$, ηp2 = 0.22, 95% CI [0.17, 1.00]), while no main effect of group and block were found, nor any additional interactions between these factors (all *p-values* > 0.06). Follow-up analyses on the time of events x group interaction revealed that, under categoric instructions, older adults recalled more memories older than 10 years than young adults (*Mdn = 0.56 vs 0.10 for older vs young, U* = 3041*, p* < 0.001, 95% CI [0.33, 0.67]), but less memories from last year (*Mdn = 0.21 vs 0.44 for older vs young, U* = 1016*, p* < 0.001, 95% CI [-0.33, -0.67]) and the past 5 years (*Mdn = 0.14 vs 0.34 for older vs young, U* = 1048*, p* < 0.001, 95% CI [-0.33, -0.001]; See **Figure S.6A**). In summary, while young adults preferred to recall recent memories (within the last 5 years and particular from the last year), older adults tended to recall more remote memories.

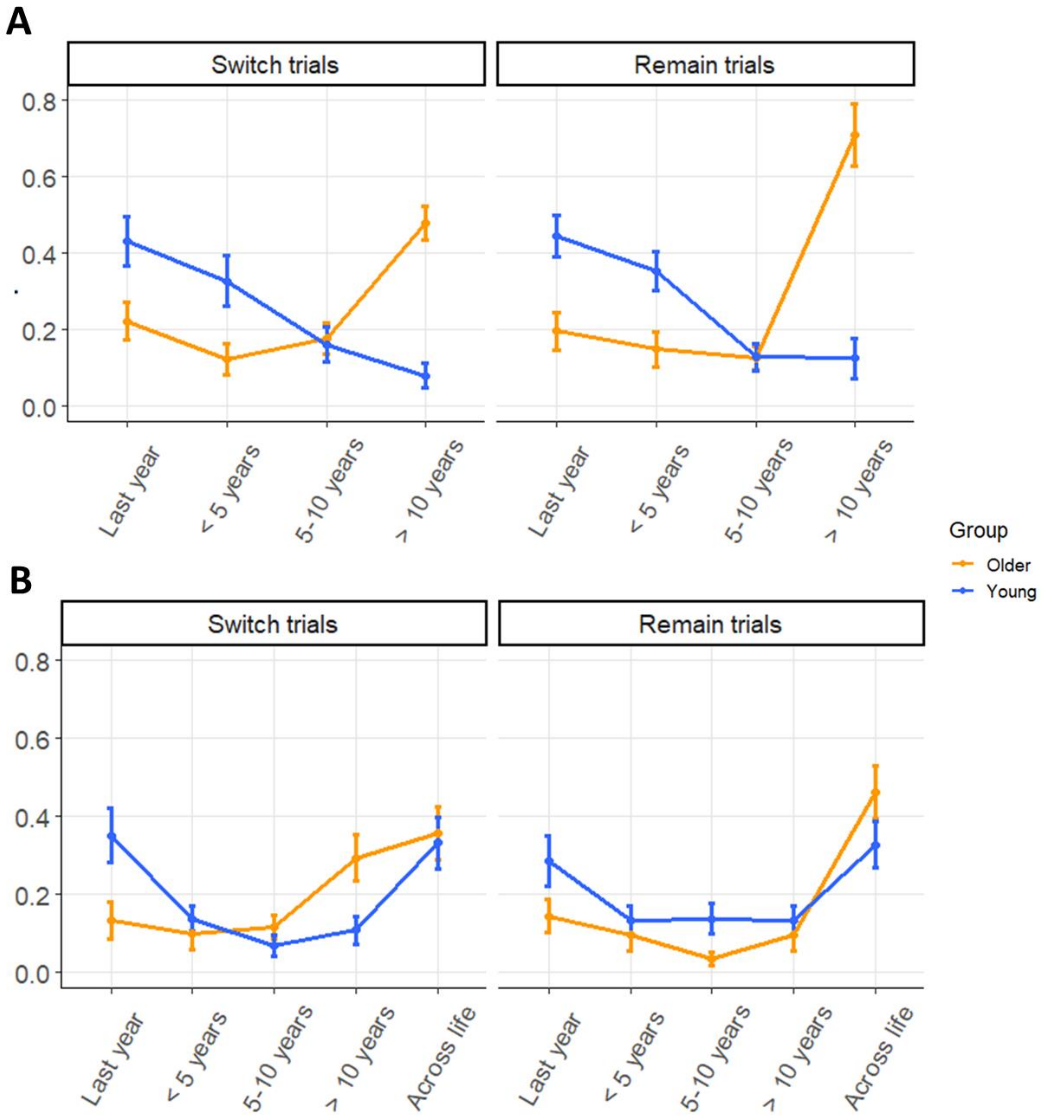

Figure S. 6. Line plot for the temporal distribution of memories under specific (A) and categoric (B) instructions in young and older adults, separate for switch and remain trials. Y values represent mean frequencies of recalled memories. Error bars represent standard errors of the mean.