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Aging Effects on the Motivational Consequences of Unsuccessful Memory Recall

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1 Abstract

The present thesis addressed whether experiences of failed recall for names of familiar faces could induce states of curiosity and drive memory benefits. Experiment 1 investigated whether older adults exhibit the same familiarity preference in information seeking, following an unsuccessful recall attempt for names of previously studied faces, as seen in younger adults. Experiment 2 considered whether acting on the curiosity induced by unsuccessful recall of names associated with familiar faces could provide benefits for the relearning of those names in both age groups. The older adults displayed a similar, if not more pronounced, positive relationship between familiarity and subsequent information seeking as was observed in the younger adults. Giving participants an opportunity to leverage their own curiosity to relearn the names of familiar faces following an unsuccessful recall attempt led to higher recall accuracy rates than exposure to names under conditions in which curiosity could not be acted upon.

Keywords

Familiarity; Aging; Curiosity; Memory Retrieval; Learning

Summary for Lay Audience

The main goal of the present thesis aimed to understand whether being unable to recall the name of familiar faces triggers curiosity for those names and whether any such curiosity has learning benefits. Experiment 1 sought out to replicate the results from a study by Brooks and colleagues (2023) in which a group of younger adults demonstrated a preference to explore the names of previously studied familiar faces – rather than completely novel ones, after they were previously unsuccessful at recalling them. Critically, Experiment 1 also investigated whether the same relationship between face familiarity and name exploration persists in older adults as successful name recall is often more difficult for this age group. Experiment 2 investigated how providing participants with the opportunity to follow their own curiosity when choosing the face-name association to learn might benefit their recall performance. Results from Experiment 1 demonstrated that both younger and older participants were more likely to choose to explore the names for the faces that were more familiar to them. This suggests a positive relationship between subjective familiarity and information seeking behaviour. Experiment 2 revealed in both younger and older adults that an opportunity to follow one's curiosity has benefits for the relearning of names that previously could not be recalled, leading to a boost in name recall on subsequent occasions. Compared to the group of participants who did not have a choice in selecting names to explore, participants who were given a choice demonstrated greater improvements from the initial recall test to the final recall test. Overall, the results of the current thesis demonstrated that curiosity is not only helpful when learning new information, but it also provides memory benefits when relearning familiar information that cannot be accessed easily when probed. These results provide many directions for follow-up research such as investigating the underlying brain mechanisms that may be responsible for the curiosity-driven memory benefit during relearning. Another direction would investigate whether the results can be leveraged to overcome recall problems in real life situations in which names (for example, those of celebrities) do not easily come to mind in older adults.

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Chapter 1

2 General Introduction

The United Nations (UN) announced, 2021-2030 will be the decade of healthy aging (World Health Organization, n.d.). Representatives of this global collaboration determined that implementing strategies for improved long-term care, agism reduction, age-friendly environments, and integrated care, will benefit not only older adults but also the community that surrounds them (World Health Organization, n.d.). Integrated health care refers to the collaboration between various health professionals to provide complete treatment to patients with the goal of improving overall well-being (American Psychological Association, n.d.). One focus of integrated care relates to intervention. Understanding how we can provide integrative care techniques to reduce age-related health issues will in turn reduce the need for additional services regarding rehabilitation and palliative care. The key age-related health issue that the research throughout this paper targets is memory decline, especially for face-name associations, given that decreased memory recall is considered to be a hallmark of cognitive aging (Crook & West, 1990). For older adults, having difficulty remembering the name of someone whom they meet may add unnecessary frustration to their lives (Benjamin, 1987). If older adults frequently have trouble remembering face-name associations, they may even begin to isolate themselves to avoid social encounters (Read et al., 2020). In the present thesis, I sought to conduct research with the goal of examining whether experiences of failed recall of the name of familiar faces may have beneficial functional consequences at the level of inducing states of curiosity in older individuals. Critically, this research aimed to determine whether any such curiosity effects could be leveraged for relearning so to as to help overcome memory deficits in name recall.

2.1 Reduced recall but preserved accuracy of familiarity assessment in older adults

Although multiple memory processes are generally affected by aging (Craik et al., 1995), there is a difference in older adults' memory abilities for semantic information compared to episodic information (Allen et al., 2002). Semantic memory refers to memory for general knowledge while episodic memory refers to memory for personally experienced events (Tulving, 1972, 2002). A recent study by St. Laurent and colleagues (2011) illustrates the specificity of age-related changes in memory functioning. The authors investigated the influence of aging on the neural correlates of autobiographical, episodic, and semantic memory retrieval. The tasks were the same across all conditions aside from the type of memory probed during retrieval. While in an fMRI scan, participants were shown a photograph along with a cue word aimed to direct attention to the gist of the photograph and then, were asked either a question about a specific element from the photograph (episodic memory condition), asked a general knowledge question related to the gist of the photograph (semantic condition), or instructed to retrieve a personal memory that was related to the photograph (autobiographical condition). Behavioural results from this study demonstrated relatively well-preserved semantic memory in the older adults whereas their autobiographical memory and episodic memory were impaired compared to the younger adults (St-Laurent et al., 2011). A hallmark of episodic memory is the ability to recall previously learnt information and such recall is typically impaired in older adults (Craik & McDowd, 1987).

Although episodic memory often is severely affected in older individuals, there are still differences in older adults' ability to recollect versus recognize episodic information (for review see Rhodes et al., 2019). The difference between recollection and familiarity in recognition memory can be illustrated using the common example of recognizing a person as being familiar but being unable to recollect any pertinent information regarding a prior encounter (Yonelinas, 2002). Yonelinas (2002), discussed in a review that there are two partially distinct neural pathways that support these two memory processes. Recollection memory relies on the hippocampus and the prefrontal cortex while recognition memory relies more on regions that surround the hippocampus (Yonelinas, 2002). Koen and Yonelinas (2016) conducted a study that compared recollection and familiarity in healthy aging adults using multiple estimation methods to probe their contributions to memory performance. Estimates of recollection, along with estimates of familiarity were obtained from tests of recognition memory that involved the Remember/Know (RK) procedure, assessment of receiver operating characteristic (ROC) based on confidence judgments, and the process dissociation (PD) procedure in older as compared to younger adults. Results from this study demonstrated that the estimates of recollection, but not of familiarity, were impaired with aging. This was revealed through a significant negative correlation between the measures of familiarity and chronological age (Koen & Yonelinas, 2016). Another study that directly compared recall and recognition accuracy required a group of younger and older adults to study the same lists of words (Danckert & Craik, 2013). Following the presentation of each list, participants completed an interference task and were then given a set amount of time for free recall for the words they had previously studied. This procedure continued for ten study lists. After going through all study lists using this procedure, a recognition test was conducted that consisted of 200 words they had previously studied as well as 200 new lure words. Participants were instructed to indicate whether they recognized each word using a yes/no judgment. The results from this study revealed that the difference in recall accuracy between the two age groups was disproportionately greater than the difference in recognition accuracy between the two age groups with the older adults showing poorer performance (Danckert & Craik, 2013). This type of recall deficit is typically interpreted as a marker of impaired recollection from episodic memory and has been observed in many other studies (for recent meta-analysis see Rhodes et al., 2019). Applying this line of work to the realm of memory for faces, Bartlett and Fulton (1991) conducted a study to test familiarity and recognition accuracy of faces for both older and younger adults. In this study, both age groups were shown a series of faces and asked to judge each item’s subjective familiarity and episodic recognition (had they seen this face previously). Once the participants had finished viewing the set of faces, they were shown the same faces again and were asked to rate how typical the face was on a 7-point Likert scale. Results from this experiment indicated that older adults made more false recognition judgments than the younger adults; however, the proportion of familiar judgments were similar between both age groups (Bartlett & Fulton, 1991). Although instances of false recognition may sometimes be higher among older adults, familiarity judgments tend to be relatively well-preserved throughout adulthood (Bartlett & Fulton, 1991; Bastin & Van der Linden, 2003; Koen & Yonelinas, 2014).

2.2 Curiosity-driven memory benefits and their underlying mechanisms

Currently, little is known regarding whether preserved familiarity could be leveraged to overcome recall deficits among older and younger adults. Consideration of the use of curiosity might offer hints as to how this may be done. Although many definitions of curiosity exist, a widely accepted broader conceptualization is that curiosity is the intrinsic motivation for gathering new or missing information (Berlyne, 1954). In the past few decades, research on curiosity has focused on the memory benefits of curiosity and the situations in which curiosity is induced. This has been of particular interest in educational literature (see Grossnickle, 2016; Hidi & Renninger, 2020; Lamnina & Chase, 2019). A study from Gruber and colleagues (2014) expanded the curiosity literature by investigating the situations in which intrinsic motivational states can affect learning. During the screening phase, participants went through trials where they were first shown a trivia question and then asked to rate their likelihood of knowing the answer and their curiosity rating for the question. This screening phase served to collect high- and low-level curiosity questions that participants also rated as a low likelihood that they would know the answer to create a collection of questions that were individualized for each participant. An equal number of high- and low- curiosity questions were then used in a study phase where participants were shown a question, then shown a random face, followed by the presentation of the answer. Results from this study showed an increase in activation in the nucleus accumbens and the left substania nigra/ventral tegmental area (SN/VTA; Gruber et al., 2014). The increased activation was associated with the anticipation of the rewarding information rather than the presentation of the answer. Along with this, participants showed better recall for the trivia answers for questions they rated as evoking higher levels of curiosity. Participants also demonstrated improved memory for incidental information that was presented in proximity to curiosity eliciting stimuli. Another notable study that analyzed the underlying mechanisms of curiosity-driven memory benefits was conducted by Kang and colleagues (2008). In this study, participants took part in a task that consisted of 40 trivia questions intended to evoke a range of curiosity levels while in an MRI scanner. The results from this experiment showed a significant correlation between curiosity level and activation in brain regions that are associated with anticipation of reward (Kang et al., 2008). Regions that were significantly activated following the presentation of the questions included the left caudate, bilateral prefrontal cortex (PFC), and parahippocampal gyri (PHG). Once the answers were presented, areas linked to learning and memory had stronger activations in response to incorrect answers compared to correct answers. The results from Kang and colleagues (2008) were one of the first of its kind to demonstrate that curiosity is found in anticipation of rewarding information and can lead to enhanced memory for new information.

A systematic review by Sakaki and colleagues (2018) suggests that curiosity may be a key to healthy aging in older adults. As summarized above, several studies looked at the memory related benefits of curiosity and found that for both directly learned stimuli and incidental stimuli, items that spark higher levels of curiosity are better remembered in subsequent memory tests (see Gruber et al., 2014; Kang et al., 2008). These benefits are repeatedly shown in younger adults but recently were revealed in older adults as well (see Galli et al., 2018; McGillivray et al., 2015). A study conducted by Galli and colleagues (2018) used trivia questions to measure curiosity levels and subsequent memory performance. Participants were asked to rate their curiosity to learn the answer for a selection of trivia questions and then asked to attend to task-irrelevant faces between the presentation of each question. Trivia questions were used in this study to test how curiosity affects memory accuracy for semantic information (Galli et al., 2018). This study was able to demonstrate improved recall for both the answers to the trivia questions that elicited high levels of curiosity and the incidentally learned faces that were presented around high curiosity eliciting questions in both older and younger adults. The recognition accuracy for the incidental face stimuli was similar for both age groups and although both age groups had higher recall for trivia questions that elicited high levels of curiosity, the younger adults had higher recall rates overall (Galli et al., 2018). These findings suggest that curiosity and the curiosity-related memory benefits that were demonstrated previously in younger adults are preserved in older adults (Galli et al., 2018). Another study by McGillivray et al. (2015) used a similar paradigm in which younger and older participants were shown a series of trivia questions and were asked to rate how curious they were to learn the answer, provide confidence and interest ratings, as well as provide judgments of learning (JOL) after learning the answer to the trivia question. The results from this study also demonstrate a preserved curiosity-driven memory benefit for the semantic information. The benefits shown for the older adults persisted for a week following the initial learning trial for the study. Both studies used semantic stimuli to test the learning benefits of curiosity; however, memory for semantic information is relatively well-preserved as individuals age (Haitas et al., 2021). A research question that has received limited coverage in the literature so far relates to the curiosity-driven memory benefits for episodic information in older adults. It is important to address this question given that episodic memory is very sensitive to effects of aging and neurodegenerative diseases (Kinugawa et al., 2013; Rönnlund et al., 2005).

The extant literature shows that the learning benefits of curiosity stem from activity in the mesolimbic dopaminergic reward system of the brain (for review see Cervera et al., 2020). Dopamine plays a major role in the reinforcement and motivation of actions (Bromberg-Martin et al., 2010). The motivational and rewarding feelings experienced when in a state of curiosity are hypothesized to be the reason for the memory benefits associated with curiosity. A key theory that proposes specific mechanisms that may support the role curiosity plays in learning and memory is the Prediction, Appraisal, Curiosity and Exploration (PACE) framework (Gruber & Ranganath, 2019). The PACE framework uses cognitive processes, neural circuits, behaviours, and subjective experiences to explain curiosity and its related memory benefits. A specific component of the framework outlines how the states of curiosity modulate the activity in the dopaminergic rewards pathway. An increase in dopaminergic circuit activity as a response to a state of high curiosity has been found to improve encoding and consolidation of memory (Gruber & Ranganath, 2019), and this curiosity-driven benefit can be extended to incidental information (Gruber et al., 2014). The mesolimbic system involves projections of the neurotransmitter, dopamine, from the ventral tegmental area (VTA) to the nucleus accumbens (Elsworth & Roth, 2009). Together, the mesolimbic reward system and the hippocampus are understood to form a functional loop that controls learning (Lisman & Grace, 2005). As the hippocampus is a central brain structure involved in memory consolidation (Squire et al., 2004), increasing the activity of the reward circuit around the hippocampus will strengthen this consolidation (Gruber et al., 2014). According to Lisman and Grace (2005) and Gruber and Ranganath (2019), activation of this functional loop begins when the hippocampus identifies novel information that has not yet been stored in the long-term memory system. A signal regarding the novel information is conveyed through the subiculum, nucleus accumbens, and ventral pallidum to the VTA where it triggers firing of neurons that are novelty dependent. Dopamine is then released in the hippocampus which produces an enhancement of long-term potentiation and learning (Lisman & Grace, 2005). Critically, findings from studies that have investigated the brain mechanisms responsible for the learning benefit of curiosity have repeatedly found increased activation of reward pathways in anticipation of the reward (Gruber et al., 2014; Kang et al., 2008) similar to that of extrinsic reward (Bromberg-Martin et al., 2010).

Research on cognitive aging has provided evidence for a decline in dopamine-dependent functioning with age (Morgan, 1987). A proposal by Düzel and colleagues (2010) highlights a framework entitled ‘Novelty-related Motivation of Anticipation and exploration by Dopamine’ (NOMAD) that links novelty, dopamine, long-term memory, plasticity, and energization to each other and in relation to aging. Maximizing the use of this mechanism has been proposed as a possible mechanism to reduce or delay age-related memory decline (Düzel et al., 2010; Sakaki et al., 2018). Although dopamine receptors and transporters are reduced in normal aging, dopamine synthesis capacity may not be as affected (Karrer et al., 2017). The NOMAD theory suggests that in highly motivating circumstances (e.g., in a state of high curiosity), older adults can utilize their remaining dopaminergic functionality to overcome age differences in cognitive function (Karrer et al., 2017). It is also suggested that older adults can use upregulated dopamine synthesis capacity as a compensatory mechanism for the reduction of dopamine receptors (Braskie et al., 2008). This compensatory mechanism combined with the minimized age differences in cognitive function found when the stimuli are personally salient and/or more motivating (Charles et al., 2003; Swirsky & Spaniol, 2019) may explain why the previously described curiosity-driven memory benefits persist as individuals age. Understanding the ways in which the dopaminergic system compensates for the decline in dopamine receptors and transporter can have many positive implications for normal aging adults but also those with Parkinson’s disease (Kaasinen & Rinne, 2002).

2.3 Relationship between curiosity, familiarity, and information-seeking behaviour

Although curiosity effects are often driven by novelty, the goal of the present study was to investigate whether the states of familiarity that are associated with unsuccessful recall in older individuals may also induce curiosity, specifically for the information that could not be recalled. A common example that adults of all ages may find themselves in and that illustrates this issue in a real-world situation, involves being at a gathering with new people. When an individual is introduced to someone new and then they see that person later in the evening, they may be unable to remember their name. In a situation like this, a likely next step is to seek out the person who introduced them, so they can be reminded of their name. This anecdote builds the foundation of the present thesis as an unsuccessful recall attempt that leads to seeking out the name associated with the familiar face describes the three key ideas involved in the current work. Thus far, I have discussed how curiosity has been shown to drive learning benefits (Galli et al., 2018; Gruber et al., 2014) and how, although recall is generally affected by aging, familiarity-based recognition is relatively well-preserved (Rhodes et al., 2019). The following section will connect the concepts of curiosity, preserved feelings of familiarity, and subsequent information-seeking behaviour in order to provide justification for the idea that familiarity-induced curiosity could offer a path towards overcoming age-related difficulties with recall.

To leverage any such potential benefits of curiosity to overcome age-related cognitive deficits, a comprehensive understanding of the factors that lead to curiosity and of how curiosity can be exhibited is critical. Kashdan and colleagues (2020) have proposed five dimensions for curiosity: *Joyous Exploration* (rewarding experience to seek out new information), *Deprivation Sensitivity* (aversion to missing information), *Stress Tolerance* (ability to accept doubt appearing due to new or complex experiences), *Social Curiosity* (showing interest in other individuals' thoughts and actions), and *Thrill Seeking* (those who enjoy taking risks and acquiring novel experiences). When an individual scores high on any of these dimensions of curiosity, they are more likely to seek out information (Kashdan et al., 2018). The 5-Dimensional curiosity scale is based on trait curiosity which has been shown to decrease throughout adulthood, however, state curiosity appears to be maintained during aging (Chu & Fung, 2022).

To measure state curiosity in an experimental setting it is possible to focus on objective markers of an individual's information-seeking behaviour or to can ask them how curious they are about an item, which measures curiosity at the subjective level. Information-seeking can be driven by either intrinsic or extrinsic motivation; however, curiosity is typically thought of as the result of an intrinsic desire to reduce uncertainty. Therefore, seeking-out the information you are uncertain about can satisfy one's curiosity (Gottlieb et al., 2013). An example of the link between curiosity and information-seeking that can be found in the real-world is the act of seeking out news and information online. The pandemic provided Abir et al. (2022) a unique way to study online information-seeking and curiosity during the early phase of the COVID-19 pandemic. In a study with a large sample size, researchers measured information-seeking, learning, and concern level for COVID-19 as a representation of motivation. They found an association between self-reported levels of concern for COVID-19 and increased seeking of COVID-19 related information as well as better memory for the newly acquired information (Abir et al., 2022). This study was one of the first to demonstrate the energizing effect of motivation on information-seeking which they hypothesize to be due to the motivation levels changing the average expected utility of the information being sought out. Many of the original theories of curiosity proposed information-seeking to only be driven by the utility of the information (Stigler, 1961); however, Loewenstein's theory (1994) indicates curiosity and information-seeking may arise from the perception of a gap in knowledge.

A recent development in the curiosity literature that builds on Loewenstein's theory (1994) is that it may not always be novel information that drives curiosity. Instead, familiar information that cannot be recalled may also point to a gap in knowledge and associated feelings of uncertainty that can motivate information-seeking behaviour (Brooks et al., 2021, 2023; Metcalfe et al., 2020). With this development in the curiosity literature, Metcalfe and colleagues (2020) expanded on this idea of an information gap by indicating curiosity may represent a metacognitive feeling state that is related to an individual's Region of Proximal Learning (RPL). When a person believes they are close to knowing a piece of information, they may be more likely to seek out that missing, rather than completely novel, information (Metcalfe et al., 2020). The RPL model proposes that when an individual has low confidence and provides a low rating of a metacognitive judgment (i.e., feeling-of-knowing judgment or familiarity judgment), they are less likely to seek-out information. Conversely, high levels of curiosity paired with high ratings for a metacognitive judgment creates the ideal scenario for seeking out and learning the information. Once an individual has 'mastered' the information, they will no longer be curious about the information and will no longer seek it out (Metcalfe et al., 2020).

A study by Brooks and colleagues (2023) investigated circumstances under which familiarity rather than novelty can induce curiosity in the context of memory retrieval. The critical retrieval factors identified in this work were whether recall was required, the perceived recall success, and the corresponding metacognitive retrieval experiences. One of the experiments closely resembled the paradigm used for the two experiments employed in the current paper. A group of younger adults were subject to a study phase, followed by a judgement phase and an exploration phase. The study phase consisted of viewing 52 face-name pairs while they were instructed to remember the association. The judgment phase had four conditions that the participants were randomly assigned to: familiarity rating with a recall attempt, feeling-of-knowing (FOK) judgment with a recall attempt, familiarity rating without a recall attempt, and FOK judgment without a recall attempt. All 52 faces from the study phase were shown along with 52 additional faces that served as the novel stimuli. Each face was shown one at a time and participants were asked to recall the corresponding first and/or last name for each face. Both the FOK and familiarity judgments were rated on 1 to 6 scale where 1 represented a new face and the 6 represented an old face. Once participants completed all 104 trials, they moved on to the final phase where the participants were shown two faces side by side. One face was a previously studied face while the other was a novel face from the judgment phase. The task in the final phase was to select which face they would like to explore the name for. The goal was to understand if any of the specific conditions led to an increase in exploration of the familiar items compared to the novel items. Results demonstrated that in all conditions, there was a significant positive relationship between ratings for the metacognitive judgments and subsequent information-seeking behaviour (Brooks et al., 2023). In other words, participants sought out the faces they had rated as more familiar or the faces whose names they thought they were more likely to recognize, regardless of whether a recall attempt was made. This study also found a significant positive correlation between the recall response time (RT) for trials where recall was unsuccessful and the subjective familiarity ratings indicating people spend more time searching their memory for the name of a face that appear to be more familiar (Brooks et al., 2023). The act of searching one's memory is a form of internal information-seeking and this evidence can therefore be interpreted as another demonstration of the positive relationship between curiosity and familiarity.

2.4 Current Study

The present study's first aim was to replicate the findings from Brooks and colleagues (2023) who found a positive relationship between familiarity and subsequent information-seeking behaviour. The second aim was to investigate whether the same relationship between familiarity and information-seeking exists for older adults. The second experiment aimed to determine whether inducing curiosity through preserved familiarity could lead to significant benefits of relearning associated information following an unsuccessful recall attempt. Based on the literature reviewed, several key findings emerge suggesting that curiosity may indeed be a motivational force that could be leveraged to overcome recall deficits for names associated with familiar faces in older adults. Previous work showed that the curiosity-driven memory benefit is preserved in older adults for semantic information (Galli et al., 2018). The present study expands on this finding to investigate whether the same curiosity-driven memory benefit is preserved in older adults for episodic information.

Based on the study by Brooks et al. (2023) that investigated the conditions that led to a familiarity preference over novelty in information-seeking behaviour, Experiment 1 aims to replicate the findings from this study in young adults as well as to confirm that this pattern holds in healthy older adults. Experiment 2 introduces additional conditions to determine whether familiarity induced curiosity may also have benefits for the relearning of information that could not be recalled. Specifically, does allowing individuals to follow their own curiosity when selecting the information to relearn have greater memory benefits compared to having the information to relearn assigned to them. Experiment 2 investigates this idea within a group of younger adults but also older adults to understand whether this benefit is preserved as individuals age.

Chapter 2

3 Experiment 1

The aims for Experiment 1 are twofold. The first aim was to replicate the findings from the study by Brooks and colleagues (2023) in which younger adults showed a familiarity preference for the items that they were more curious about and subsequently chose to explore. It was expected that the same relationship would be preserved in a group of older adult participants. Experiment 1a was the original replication of the study design by Brooks and colleagues (2023) and Experiment 1b employed a similar paradigm with the addition of multiple-choice questions aimed to test participants' level of attention to the details of the instructions. The familiarity preference and its relationship to the information-seeking behaviours was expected to be demonstrated through a significant positive correlation between the subjective familiarity ratings and the subsequent information-seeking behaviour. A significant correlation between the subjective familiarity ratings and the corresponding response times for preceding unsuccessful recall attempts would further solidify the preservation of the relationship between familiarity and information-seeking. The information-seeking here relates to the time spent searching one's memory for the corresponding name of a familiar face. These expected correlations are anticipated to be observed in both age groups. Finally, it was predicted that the older adults will have lower recall accuracy compared to the younger adults but comparable performance in familiarity discrimination. If the findings work out as predicted, I plan to examine whether any preserved curiosity effects can be leveraged to overcome recall deficits associated with healthy aging. The current experiment included two highly similar variants of the same general procedure (Experiment 1a and 1b). The only difference between these variants was addition of multiple-choice questions relating to the instructions in Experiment 1b that served as independent assessment of the data quality.

3.1 Method

3.1.1 Participants

Experiment 1a – After recruitment through the online platform Prolific (https://www.prolific.co/), 72 English-speaking participants completed Experiment 1a. Participants were recruited from one of two age groups: young adults (age range 18-35 years; *M* = 28.1, *SD* = 5.12) and older adults (age range 60-85; *M* = 70.0, *SD* = 4.13). The final sample consisted of 37 participants in the older adult age group (19 females) and 32 participants in a young adult age group (18 females, 1 preferred not to say). The following exclusion criteria that were implemented for all participants were based on the criteria used in the study by Brooks and colleagues (2023) to ensure the data collected online were of similar quality to those collected in person. Any participant who had a response time greater than 10 s during any catch trial or whose break between phases was greater than 200 s was excluded. Three participants were excluded due to their break between phases being greater than 200 s but no participants were excluded based on the criterion for the catch trials. If a participant failed to use the full familiarity rating scale or made recall attempts for every trial, they would be excluded as they did not follow the instructions. No participants were excluded for either of these criteria.

Experiment 1b – After recruitment from the online platform Prolific (https://www.prolific.co/), 51 English-speaking participants successfully completed Experiment 1b. Participants were recruited from one of two age groups: young adults and older adults. The final sample consisted of 21 participants in the older adult age group (age range 60-85 years; *M* = 66.1, *SD* = 4.98, 9 females) and 30 participants in the younger adult age group (age range 18-35 years; *M* = 28.9, *SD* = 4.40, 8 females). No participants were excluded based on the same exclusion criteria that was used for Experiment 1a. Participants who completed Experiment 1a were excluded from recruitment for Experiment 1b.

The study was approved by the Western University's Non-Medical Research Ethics Board. Informed consent was acquired from each participant before the start of the experiment. A payment of £9 was given to each participant as compensation for their time. All experiments were performed in accordance with the approved guidelines and regulations.

3.1.2 Materials

The face stimuli used in this paradigm came from the Face-Name Association Task (https://cogniciti.com/). A total of 104 faces were selected from the database and were balanced for age, race, and gender. The photos were in black and white, and all faces showed a neutral emotional expression. The face stimuli set has been used for many aging studies (LaPlume, Anderson, et al., 2022; LaPlume, McKetton, et al., 2022). A different selection of faces was used in this study compared to the study by Brooks and colleagues (2023). The new dataset of faces included older and younger faces that were balanced for gender and race. The same list of names was used in this study as was selected for the study by Brooks and colleagues (2023). Names were selected from the U.S. Census Bureau 1990 (https://catalog.data.gov/dataset/names-from-census-1990). A total of 104 first names with medium frequency within the population (frequency rates between 0.15% and 0.50%) were selected for the current study. There were four lists of the face-name pairs to counterbalance the name that was paired with each face and to counterbalance which face-name pairs served as an old item or a novel item. The names were matched to the faces based on gender. Versions A and B had the same face-name pairs but those that appeared in the study phase in Version A served as the novel faces in Version B and vice-versa. Versions C and D had different face-name pairs than A and B. The faces that appeared in the study phase of version C served as the novel faces in Version D and vice-versa.

3.1.3 Procedure

Experiment 1a – The behavioural paradigm used for the current study was coded in PsychoPy (https://www.psychopy.org/), using the Builder tool (Peirce et al., 2019), and was administered online through Pavlovia (https://pavlovia.org/). With the experiment being conducted online, participants used their own computers. Experiment 1a and 1b had three phases: a study phase, a memory-judgement phase, and an exploration phase (see Figure 1). The entire experiment took approximately 30 min to complete. The task set-up from this experiment was based on the familiarity task used by Brooks and colleagues (e.g., Brooks et al., 2023).

During the first phase of the experiment, participants were asked to memorize a series of 52 face-name pairs. Each pair appeared on the screen for 3 s with the name centred on the bottom of the screen and the face positioned above. A 500 ms inter-stimulus interval (ISI) then appeared, followed by the next face-name pair. A break was given halfway through the study phase. Once participants studied all 52 face-name pairs, the entire phase was repeated an additional two times for a total of three exposures of the same pairs. The pairs were presented in a random order all three times.

The second phase involved participants providing memory-judgements. In a random order, participants were presented 104 faces of which 52 had been previously seen during the study phase and 52 served as novel faces. Each face was presented one at a time and participants were first asked to recall the name and then were asked to rate how familiar the face was to them on a 6-point Likert scale from 1 to 6 (i.e., 1‘very unfamiliar’ to 6 ‘very familiar’). When prompted, participants typed their recall attempt then pressed the ‘enter’ key to move on to the familiarity question. If the name could not be recalled, participants were instructed to press the ‘enter’ key without typing a guess. Both the recall task and the familiarity judgements were self-paced. Each trial was followed by a 500 ms ISI to indicate the next trial was to begin.

The third and final phase of the experiment was the exploration phase in which I examined the influence of previously expressed familiarity for faces on subsequent information-seeking behaviour for corresponding names. During this phase of the study, participants were presented two faces side-by-side. The two faces were matched for age, race, and gender. However, one face had been studied initially during the encoding phase and the other face was a novel face whose name had not been previously studied but the face was presented during the memory-judgment phase. The side of the screen that the familiar face was presented on was randomized across trials. Participants were instructed to select for which face they would like to be shown the associated name for. The selection was made by clicking either the right or left arrow on their keyboard at the participants' own pace. Once the selection was made, the selected face and its associated name were presented together on the screen for 3 s followed by a 500 ms ISI before the next trial began. This final phase included 52 trials.

Throughout each phase of the experiment, catch trials were pseudo-randomly included as an attention check to ensure participants were engaged in the task. During the catch trials, participants were shown a blue square and were instructed to respond as quickly as possible with a button press that was not used for other tasks in the experiment. These trials occurred once in every 52 trials (i.e., one catch trial in each half of the memory-judgement phase and one during the final exploration phase).

Experiment 1b – The procedure for Experiment 1b was identical to the procedure for Experiment 1a aside from the addition of eight multiple-choice questions presented throughout the experiment between the instructions and the beginning of each phase (see Appendix A). The additional multiple-choice questions served as engagement checks as the questions asked participants about details of the instructions. With these multiple-choice questions, I was able to see whether participants understood the instructions based on their accuracy and how engaged they were based on their response time. These multiple-choice questions were added for Experiment 1b in response to an unexpected lack of difference in recall accuracy rates across the two age groups originally found in Experiment 1a.

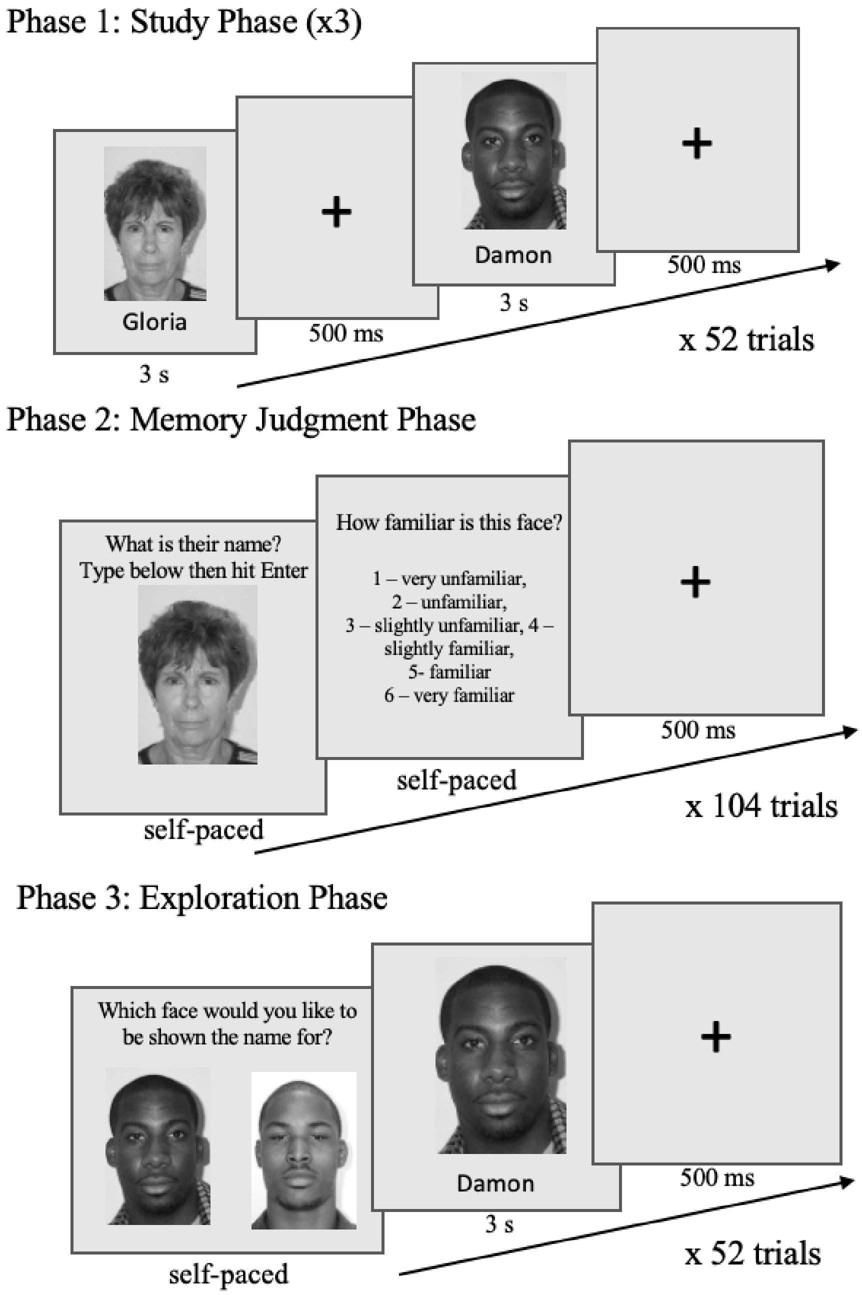


Figure 1: Behavioural paradigm. Phase 1 to 3 in Experiment 1a and 1b. In Phase 1 participants were instructed to encode a set of face-name pairs. In Phase 2, they were asked to recall the names corresponding to the faces presented. This was followed by a familiarity judgment based on a 6-point Likert scale. In Phase 3, participants were presented pairs of faces presented side-by-side and were instructed to select the one for which they could explore the corresponding name.

3.2 Results

Experiments 1a and 1b included two age groups that were compared throughout the analyses. The different analyses included one-sample t-tests, independent sample t-test, and two-way between-subjects ANOVAs. Additionally, Gamma and Pearson correlations were used to analyze the relationship between familiarity ratings and either exploration choices or recall response time (RT). The key dependent variables were the recall accuracy rates, subjective familiarity ratings, recall response times, and the exploration choices. Due to the similarities between Experiment 1a and 1b, the following description of the results combine the two datasets. Prior to pooling data from both experiments, the results were compared on key measures to ensure the two datasets did not differ significantly in any major aspect. The three key results that were compared to ensure there were no significant differences between the two groups were the recall accuracy, *d'* scores, and the relationship between familiarity ratings and subsequent information-seeking behaviours. Results showed no main effect of the experiment version for any of these measures. A specific breakdown for the results from Experiments 1a and 1b can be found in Appendix B.

3.2.1 Comparison of recall accuracy between age groups

One of the most well-documented age-related memory deficits is the recall deficit (Craik & McDowd, 1987). An independent samples t-test compared to recall accuracies of the two age groups. The recall accuracy rate was calculated by dividing the total number of successful recall attempts by the total number of trials and multiplying by 100 to find the percent of successful recall trials. It was expected that I would see a recall deficit among the older adults. However, the older adults (M = 12.75%, SD = 10.23%) did not have a significantly different recall accuracy rate compared to the younger adults (M = 12.69%, SD = 10.42%), $t(117) = 0.031$, $p = .975$ (see Figure 2).

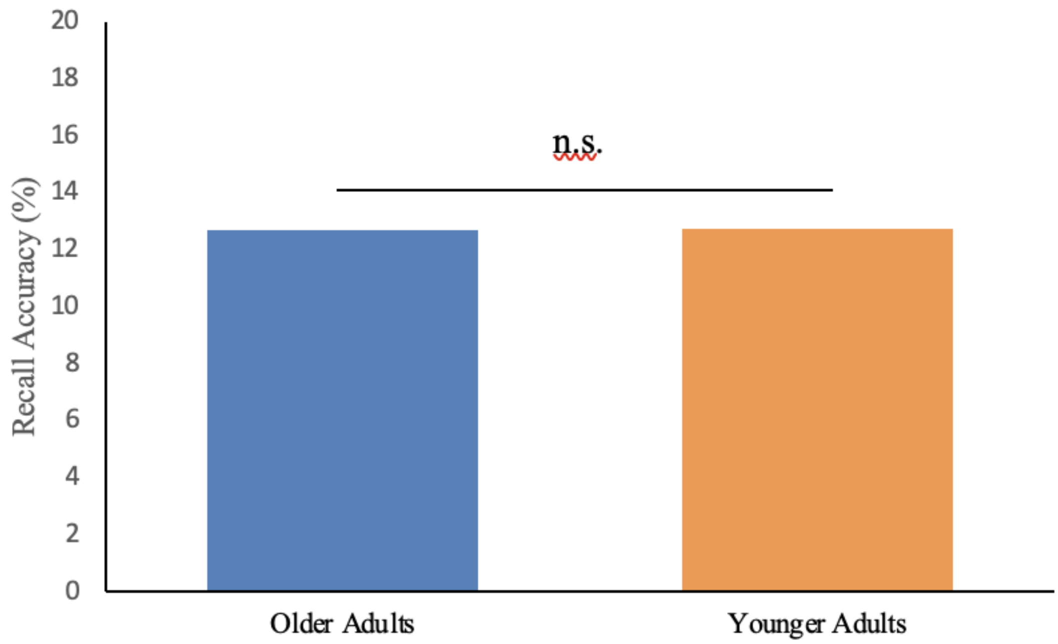


Figure 2: Overall recall accuracy for older and younger adults. The average recall accuracy rate for the older adults was not significantly different from the younger adults. n.s. p > .05.

As mentioned previously, another way to look at information-seeking is through memory search duration. It was hypothesized that if a face is more familiar, a person will spend more time trying to recall the name. Recall response time was measured as the time from initial presentation of the face until the enter key was pressed during the recall trial. For trials that ultimately ended with unsuccessful recall, older adults had an average recall response time of 4.27 s and the younger adults had an average of 3.91 s. An independent samples t-test showed no significant difference between the older adults and younger adults for their average recall response times for trials with unsuccessful recall, $t(649) = 1.21$, $p = .227$. Using a Pearson correlation, I can look at the correlation between the subjective familiarity ratings and the recall response time for trials where participants were unable to recall the associated name. Both the older adults (*Mean r* = 0.46, *SD* = 0.22) and the younger adults (*Mean r = 0.37*, *SD* = 0.22) had Pearson correlations that were significantly above zero (older adults: $t(50) = 15.19$, $p < .001$; younger adults: $t(55) = 11.57$, $p < .001$). There was a significant difference in the Pearson correlations between the two age groups, $t(105) = 2.02$, $p = .046$, where the older adults spend more time trying to recall the names they rated as more familiar when they were ultimately unable to recall the name (Figure 3).

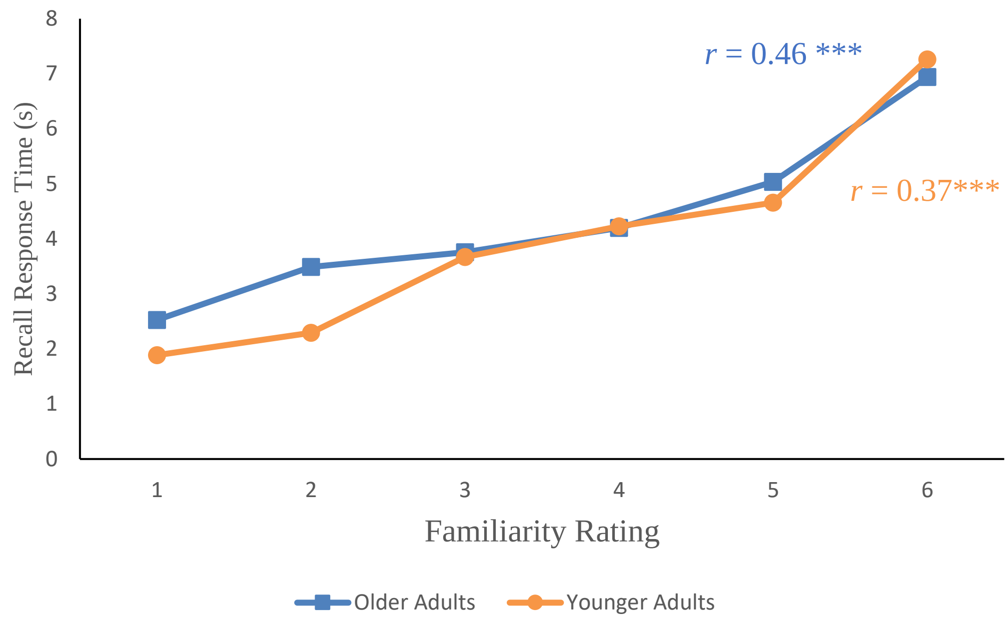


Figure 3: Average recall response time for different values of familiarity ratings in both age groups under conditions in which recall was unsuccessful. *** p < .001.

3.2.2 Comparison of familiarity ratings across age groups

A signal detection calculation and the corresponding *d'* scores were used to test for age differences in familiarity ratings. This is a measure of memory discrimination that considers hit rates in relationship to false-alarm rates. A hit suggests a participant was able to accurately describe an old face as more familiar whereas a false alarm indicates a novel face was rated as highly familiar. A *d'* value above zero demonstrates an individual was able to discriminate correctly between familiar and novel faces at an above chance level. The familiarity judgments were made on a continuous scale. To binarize the continuous familiarity rating scale for the signal detection calculation, a rating of 4-6 assigned to a previously studied face was marked as a hit and a rating of 4-6 assigned to a novel face was marked as a false alarm. A familiarity rating of 1-3 for a previously studied face is considered a miss and the same rating for a novel face was a correct rejection.

Overall, both age groups were able to differentiate between the previously shown and novel faces by correctly identifying the previously shown faces as more familiar and the novel faces as less familiar. A one-sample t-test showed the older adults (*M* = 1.97, *SD* = 0.82) had an average *d'* score that was significantly above zero, $t(56) = 18.20$, $p < .001$. Another one-sample t-test indicated that the group of younger adults (*M* = 1.70, *SD* = 0.87) also had an average *d'* score that was significantly above zero, $t(60) = 15.33$, $p < .001$. The two age groups' *d'* scores did not differ significantly when comparing them using an independent-samples t-test, $t(116) = 1.73$, $p = .086$. Both age groups had average *d'* scores significantly above zero thus demonstrating that both age groups were able to correctly identify previously presented faces as more familiar and novel faces as less familiar (see Figure 4).

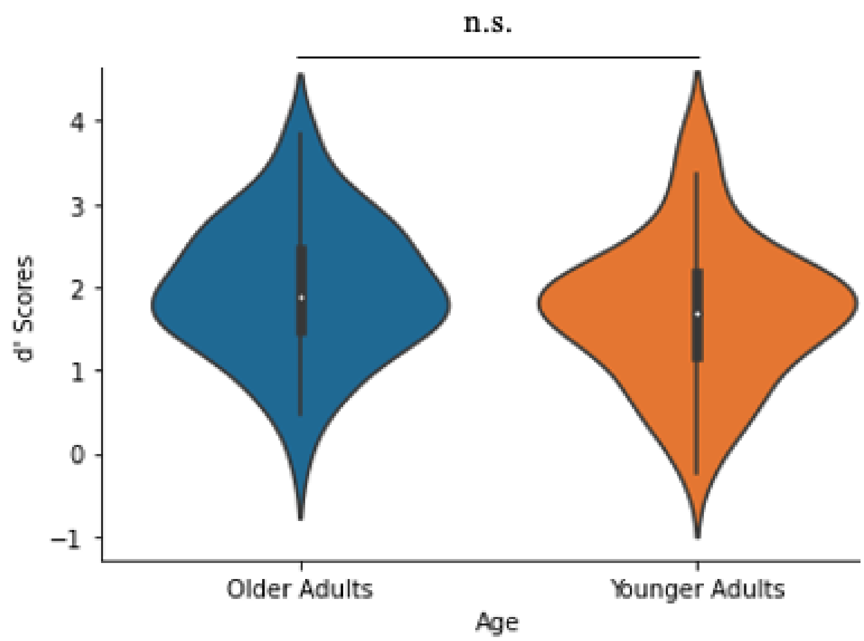


Figure 4: Violin plot of the range of d' scores for older and younger adults. Both age groups had a mean d' score above zero that did not differ across groups, indicating they were both able to discriminate previously studied faces from novel faces. n.s p > .05.

Another way to ensure participants were able to identify a previously shown face as more familiar than a novel face is to check the average familiarity rating for each face type. An independent samples t-test was used to compare the average familiarity rating of the novel faces to the previously studied faces. The older adults' familiarity ratings for the previously studied faces (*M* = 4.58, *SD* = 0.73) were significantly higher than the familiarity ratings for the novel faces (*M* = 1.94, *SD* = 0.53), $t(107) = 21.43$, $p < .001$. The younger adults' average familiarity ratings for the previously studied faces (*M* = 4.18, *SD* = 0.82) were significantly higher than the average familiarity ratings for the novel faces (*M* = 1.96, *SD* = 0.64), $t(117) = 16.45$, $p < .001$ (Figure 5). When the age and item type were compared in a two-way ANOVA, there was a significant main effect of item type, $F(1, 224) = 698.24$, $p < .001$, with previously studied items and a main effect of age, $F(1,224) = 4.25$, $p = .040$. There was also a significant interaction between age and item type, $F(1,224) = 4.83$, $p = .029$.

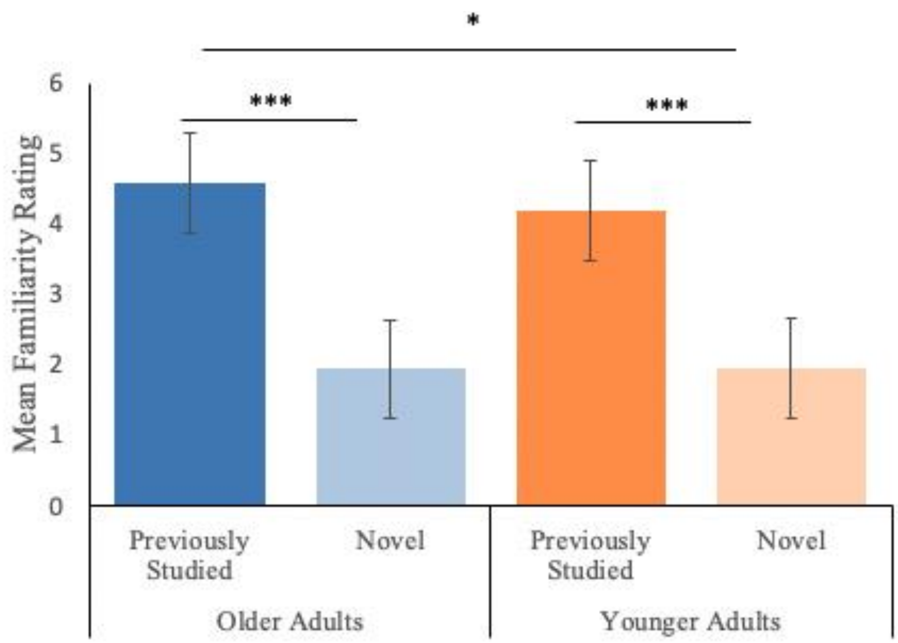


Figure 5: Average familiarity ratings for previously studied and novel faces for both age groups. The average familiarity rating for the previously studied faces was significantly higher than for the novel faces in both age groups. *** p < .001. * p < .05.

3.2.3 Preserved relationship between familiarity and subsequent information-seeking behaviours

The main question Experiment 1 aims to address is whether the familiarity preference shown in the study by Brooks and colleagues (2023) is preserved in older adults. The preservation of the familiarity preference would demonstrate that curiosity, measured objectively through information-seeking, can be induced by feelings of familiarity in the absence of successful recall. As a replication for the study by Brooks et al. (2023), I checked for an objective familiarity preference among the younger adults using the proportion of familiar faces selected for restudy. This was calculated by comparing the frequency of selecting the previously studied faces to the frequency of selecting a novel face during the exploration phase. An independent samples t-test was used to compare the proportion of familiar faces selected during the exploration phase compared to the novel face for the older and younger adults. Both the group of older adults (*M* = 71.90%, *SD* = 14.68%) and the younger adults (*M* = 57.66%, *SD* = 17.93%) selected the previously studied face, or familiar face, significantly more often than the novel face, $t(112) = 15.92$, $p < .001$; $t(122) = 4.76$, $p < .001$, respectively, during the exploration phase. The older adults selected the previously studied face significantly more often than the younger adults, $t(117) = -4.71$, $p < .001$. Participants in both age groups chose to explore the objectively more familiar face more often than the novel face during the exploration phase of the experiment. Using a Gamma correlation, I compared the subjective familiarity ratings to the information-seeking behaviour to determine if participants selected the subjectively more familiar face to explore following an unsuccessful recall attempt (Figure 6). The Gamma correlation was significantly above zero for both the older adult group (*Mean* $\gamma = 0.51$, *SD* = 0.33; $t(55) = 11.62$, $p < .001$) and the younger adult group (*Mean* $\gamma = 0.28$, *SD* =0.37; $t(60) = 7.74$, $p < .001$). There was also a significant difference between the two age groups, $t(115) = 3.52$, $p < .001$, demonstrating a stronger preference for the more familiar faces among the older adults compared to the younger adults. Due to the lack of recall deficit among the older adults, I wanted to ensure this relationship was preserved even when a recall deficit was present. To do this, I compared the relationship between the subjective familiarity ratings and the subsequent information-seeking behaviour for the younger adults with the highest recall accuracy rates to the older adults with the lowest recall accuracy rates. Older adults with the lowest recall accuracy had an average Gamma correlation (*Mean* $\gamma = 0.69$, *SD = 0.27)* that was significantly above zero, $t(27) = 13.70$, $p < .001$. Younger adults with the highest recall accuracy had an average Gamma correlation (*Mean* $\gamma = 0.30$, *SD* =0.40) that was significantly above zero, $t(29) = 4.08$, $p < .001$. The stronger preference for familiar items among the older adults also was preserved in this analysis, $t(56) = 4.34$, $p < .001$.

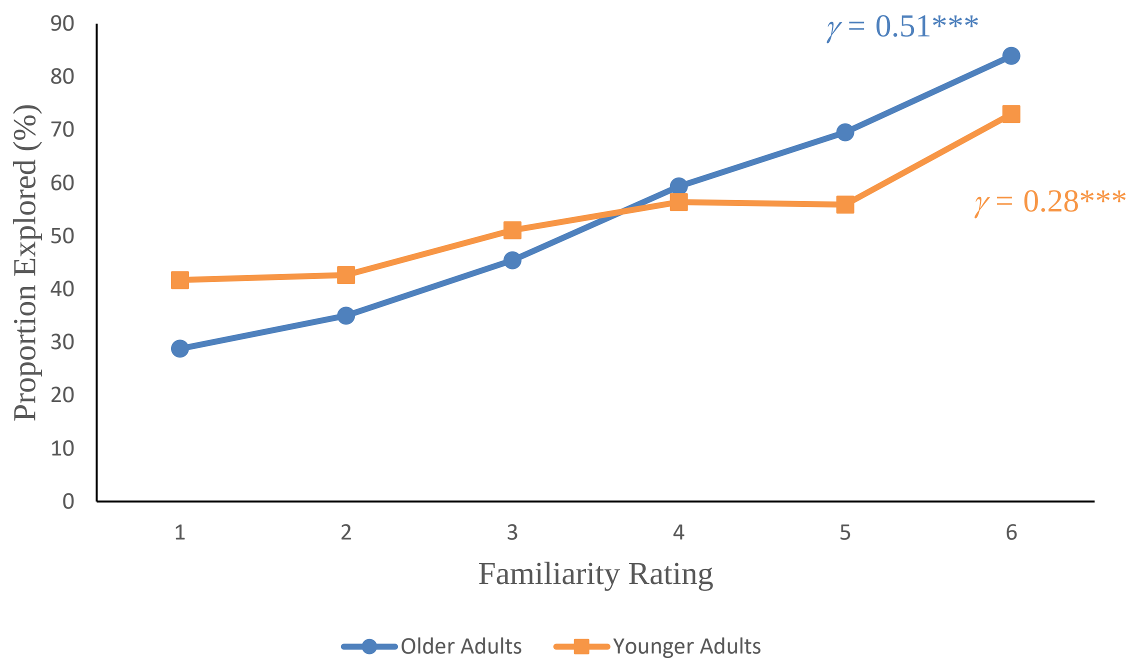


Figure 6: Relationship between familiarity ratings and information-seeking for older and younger adults. The degree of familiarity is positively correlated with subsequent information-seeking for both age groups for trials with unsuccessful recall. *** p< .001.

3.3 Discussion

Recent work has argued against the idea that for curiosity to exist, novelty must be present (Brooks et al., 2021; Wade & Kidd, 2019). Identifying a gap in knowledge can lead to information-seeking for familiar items rather than novel items (Metcalfe et al., 2020). One aim for the current study was to replicate the findings from the study by Brooks and colleagues (2023) that demonstrates this induction of curiosity for names associated with familiar faces that could not be recalled successfully. Using a behavioural paradigm that was almost identical to one employed by Brooks et al. (2023), I found the same relationship between familiarity and information-seeking in the group of younger adults. Critically, the findings of the current study also demonstrated a preservation of this relationship throughout late adulthood as the older adults had a similar, if not more pronounced, relationship between feelings of familiarity and information-seeking. This pattern was observed in the context of unimpaired familiarity discrimination in older adults. Based on the results from Experiment 1, I aim to extend the findings in a follow-up experiment in an effort to determine whether this preserved curiosity for unrecalled names of familiar items can be leveraged to help overcome recall impairments in older adults.

The results from the current study demonstrated a preservation of familiarity discrimination in older adults. Although recall from episodic memory tends to be negatively affected by aging (Koen & Yonelinas, 2014; Souchay et al., 2000), familiarity and recognition memory are relatively well-preserved throughout the human lifespan (Bastin & Van der Linden, 2003; Craik & McDowd, 1987). Therefore, the older and younger adults were expected to have accurate familiarity judgments. The ratings were compared, first by using the average familiarity ratings for the previously presented and novel faces so as to replicate the analysis from Brooks et al. (2023). Findings were confirmed with a second type of analysis using a signal detection calculation as employed in previous studies that examined familiarity and recognition memory (for review see Koen & Yonelinas, 2014). Both methods showed comparable accuracy in the familiarity judgments for both the older and younger adults. As the remaining results are discussed, it is understood that both the older and the younger adults were able to correctly identify the previously studied as more familiar than the novel faces.

An unexpected finding in Experiments 1a and 1b was the lack of a recall deficit for previously learned names in older as compared to younger adults. Recent work from other labs revealed that conducting studies online can reduce the difference in recall accuracy between younger and older adults (Swirsky & Spaniol, 2023). Douglas et al. (2023) compared the different online testing platforms and found that Prolific has the best quality data and offers the most representative samples among of all the available online platforms they tested. The older adults who participate in online studies are likely more technologically advanced compared to their same age peers who do not participate in online studies. At the same time, younger adults may not be as motivated or engaged in the task on online platforms as when tested in lab settings. When older adults are more accustomed to using technology, they see many benefits including improved episodic memory and processing speed (Chan et al., 2016). These ideas combined may account for the unexpected decrease in the difference between younger adults and older adults' recall accuracy.

The results of Experiments 1a and 1b have successfully replicated the findings from the study by Brooks and colleagues (2023). As was shown in the previous study, the younger adults in the current study preferred the more familiar faces when given an opportunity to select associated names for exploration. As an expansion on the previous study, I have found that older adults similarly prefer the more familiar faces that they previously studied for exploration. To the extent that curiosity is shown to boost learning outcomes (Gruber et al., 2014; Kang et al., 2008), an interesting question that arises from the results of Experiments 1a and 1b and this concept is whether the observed curiosity induced by face familiarity in the current study also may have benefits for the relearning of the associated names but could not be recalled successfully. This question is of particular importance in the context of cognitive aging. Experiment 2 aims to answer this question.

Chapter 3

4 Experiment 2

The aim for Experiment 2 was to expand the findings from Experiment 1 by investigating whether curiosity induced by preserved familiarity could lead to significant benefits for relearning of associated information that could not be recalled. An additional question of interest was whether any such benefits are preserved in older adults. To determine whether the effects of curiosity on subsequent information seeking go hand in hand with benefits for relearning, I conducted an experiment similar to Experiment 1b and introduced two conditions to examine the benefits of relearning. One condition provided agency to participants during information seeking behaviour, which allowed them to follow their curiosity. The other condition did not provide an opportunity to act on their curiosity. I predicted that those who can follow their own curiosity and select the faces for which they would like to be shown the associated name during the exploration phase would perform better on a subsequent recall test compared to those for whom the names were preselected. To ensure any agency effect would reflect the critical role of curiosity in learning benefits, all other aspects of the experiment were matched between the two conditions. Given that a recall deficit is a well-documented marker of age-related memory decline (see Craik & McDowd, 1987; Perrotin et al., 2006; Rhodes et al., 2019), one might expect the older adults to have a lower recall rate compared to the younger adults. To the extent that no such deficit was observed in Experiment 1, however, an alternate prediction is that with the online setup employed in this study, no recall impairment would be present in older adults in Experiment 2 either. It was also predicted that the age groups would not differ in their ability to distinguish between familiar and novel items as observed in Experiment 1 and as reported in the literature on recognition memory more broadly (Bartlett & Fulton, 1991; Bastin & Van der Linden, 2003; Koen & Yonelinas, 2014; Yonelinas, 2002).

4.1 Method

4.1.1 Participants

After recruitment from the online platform Prolific (https://www.prolific.co/), 125 English-speaking participants completed Experiment 2. The final dataset consisted of 117 participants. A total of 57 participants belonged to the younger adult group (age range 18-35; *M* = 27.9, *SD* = 4.48, 18 females, 1 non-binary/third gender) and 60 belonged to the older adult group (age range 65-80; *M* = 69.0, *SD* = 3.61, 34 females). The same exclusion criteria that were implemented for all participants was set based on the criteria used in the study by Brooks and colleagues (2023) to ensure data collected online is of similar quality to that collected in person. Any participant who had a response time greater than 10 s during any catch trial or whose break between phases was greater than 200 s. Two participants were excluded because the instructions were not followed as incorrect recall attempts were made for all trials while the instructions asked participants not to guess if they were unsure. A total of six participants were excluded due to breaks between phases being greater than 200 s. No participants were excluded based on the response time for the catch trials.

The study was approved by the Western University's Non-Medical Research Ethics Board. Informed consent was acquired from each participant before the start of the experiment. Participants were compensated £9 for their participation in the experiment. All experiments were performed in accordance with the approved guidelines and regulations.

4.1.2 Materials

The materials used for Experiment 2 were identical to those found in Experiment 1.

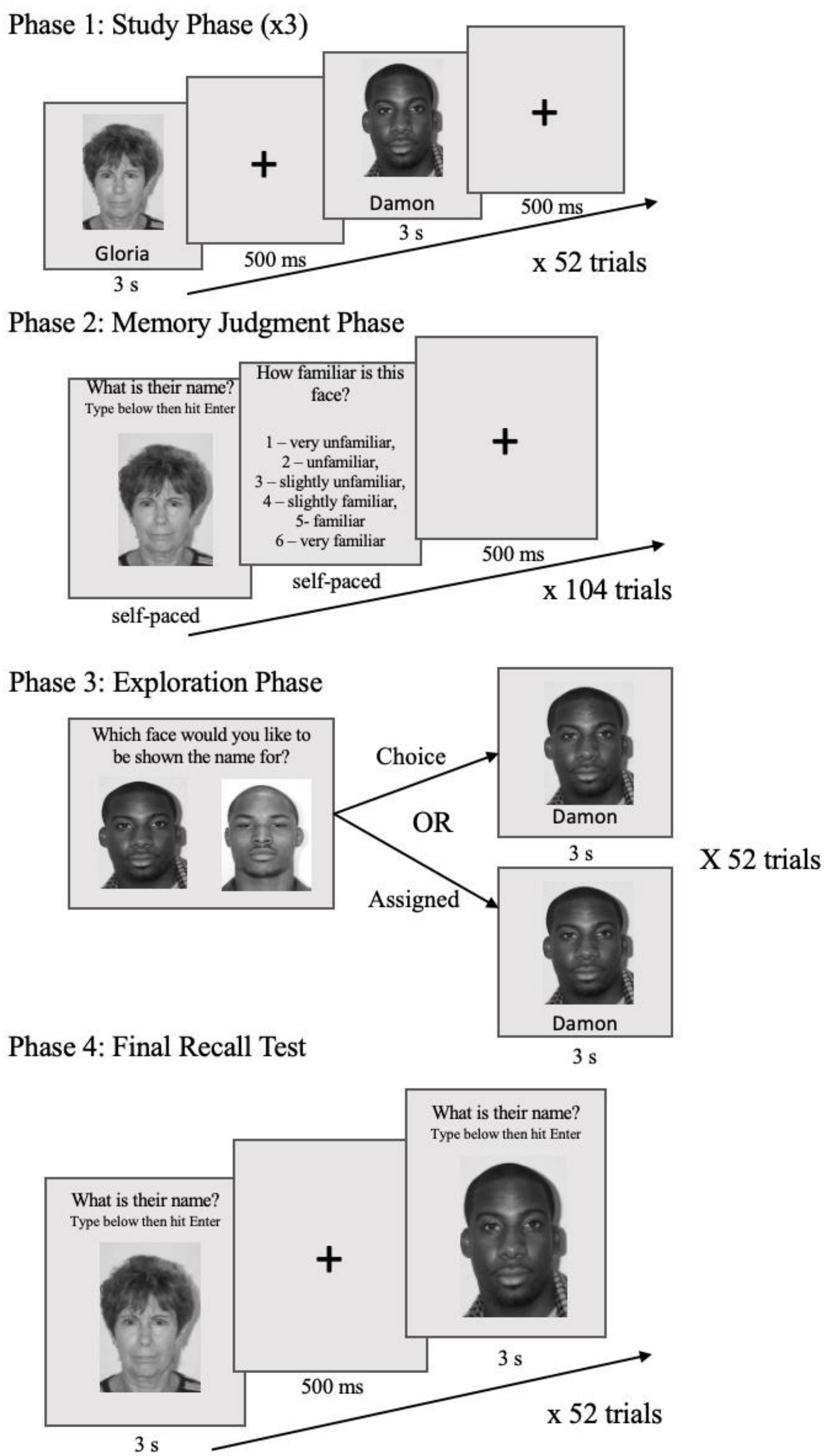
4.1.3 Procedure

The paradigm for Experiment 2 resembles that from Experiment 1b. Experiment 2 consisted of four phases: 1) a study phase, 2) a memory-judgement phase, 3) an exploration phase, and 4) a final recall test (Figure 7). The experiment took about 35 min to complete. Phases 1 and 2 were identical to the first two phases of Experiment 1b.

Before the experiment began, participants were assigned randomly to one of two conditions for the exploration phase – Assigned or Choice.

The exploration phase for the Choice condition was identical to the exploration phase in Experiment 1b. Participants randomly assigned to the Assigned condition had the same faces presented side-by-side, however, the name to be shown was preselected. To ensure the only difference between the two groups was the ability for the participants to follow their own curiosity when selecting the face to relearn the associated name for, the number of previously presented faces was randomized based on the results from Experiment 1. For each participant in the Assigned condition, a number between 22 and 41 was selected. This range reflected the average number of previously presented, familiar faces selected by participants in Experiment 1 plus or minus 1 *SD*. That randomly selected number then became the number of previously presented faces preselected for restudy. To adjust the presentation time of the face pairs in the Assigned condition, the average exploration judgment RT from Experiment 1 plus or minus 1 *SD* was used. A time between 1.5 and 3.2 s was randomly selected for each trial to match the estimated presentation time individuals experienced in the Choice group. Once the assigned time passed, the preselected face and its associated name were presented together on the screen for 3 s followed by a 500 ms ISI before the next two faces were shown as pairs. This final phase proceeded through 52 trials, as all 52 previously studied and all 52 novel faces were presented.

Another key difference between Experiment 1b and 2 was the final phase of Experiment 2 was a cued recall test for the previously studied faces. All 52 faces from the initial encoding phase were presented one at a time and participants were asked to recall the associated name. Similar to the first recall test, participants were instructed to move on to the next face if they were unsure rather than make a guess. Providing recall responses was self-paced and a 500 ms ISI was presented between trials.



Phase 1: Study Phase (x3)
Gloria
3 s
+
500 ms
Damon
3 s
+
500 ms
x 52 trials
Phase 2: Memory Judgment Phase
What is their name?
Type below then hit Enter
self-paced
How familiar is this face?
1 – very unfamiliar,
2 – unfamiliar,
3 – slightly unfamiliar,
4 – slightly familiar,
5- familiar
6 – very familiar
self-paced
+
500 ms
x 104 trials
Phase 3: Exploration Phase
Which face would you like to be shown the name for?
Choice
OR
Assigned
Damon
3 s
Damon
3 s
X 52 trials
Phase 4: Final Recall Test
What is their name?
Type below then hit Enter
3 s
+
500 ms
What is their name?
Type below then hit Enter
3 s
x 52 trials

Figure 7: Behavioural paradigm for Experiment 2. Phase 1 to 3 in Experiment 1a and 1b. In Phase 1, participants were instructed to encode a set of face-name pairs. In Phase 2, they were asked to recall the names corresponding to the faces presented. This was followed by a familiarity judgment based on a 6-point Likert scale. In Phase 3, participants were presented pairs of faces side-by-side and were assigned to either the Choice condition or Assigned condition. Those in the Choice condition were instructed to select the one for which they could explore the corresponding name whereas those in the Assigned condition had the selection made for them. In Phase 4, all participants had a final recall test only for the faces presented in Phase 1.

4.2 Results

Experiment 2 included testing of participants from two age groups in two conditions that were compared in all analyses. The different analyses included one-sample t-tests, independent sample t-tests, and two-way between subject's ANOVAs. Additionally, Gamma and Pearson correlations were used to analyze the relationship between the various measures. The key dependent variables of interest were the recall accuracy rates on the initial and final recall tests, subjective familiarity ratings, recall response times, and the exploration choices in the Choice condition. Demonstrating that the Assigned condition and Choice condition did not differ on any measure, aside from final recall performance, is important for interpretation of data on the latter and for attributing any differential benefits of relearning to agency during the exploration phase. Of particular interest in this context are the results for the initial recall phase, the *d'* prime scores, the average familiarity ratings, and finally, the number of previously presented faces shown during the exploration phase to ensure the two conditions did not differ. There were no significant differences between the two conditions in any of these key results in either age group.

4.2.1 Results from initial recall test

Before comparing the results of the two age groups, it was important to show that the two experimental conditions did not differ in their initial recall scores as the procedure was identical up to this point. A two-way ANOVA was conducted to compare the initial recall accuracies for the two age groups (older and younger adults) and the two conditions (Assigned and Choice). There was no significant main effect of condition for the initial recall test (Choice: *M* = 13.3%, *SD* = 7.91%; Assigned: *M* = 11.7%, *SD* = 8.08%), $F(1, 113) = 0.72$, $p = .399$. There also was no main effect of age for the initial recall test (Older adults: *M* = 11.7%, *SD* = 10.2%; Younger adults: *M* = 11.7%, *SD* = 8.08%), $F(1, 113) = 1.04$, $p = .311$. The interaction between age and condition was not significant, $F(1, 113) = 0.643$, $p = .424$.

4.2.2 Comparison of familiarity ratings across groups

A two-way ANOVA was used to compare the *d'* scores from all trials between the two conditions (Assigned versus Choice) and two age groups (older adults versus younger adults). One-sample t-tests were used to ensure all the groups had *d'* scores that were significantly above zero. There was no significant main effect of condition for the *d'* scores (Choice: *M* = 2.02, *SD* = 0.73; Assigned: *M* = 1.91, *SD* = 0.79), $F(1,110) = 0.575$, $p = .450$. The older adults had an average *d'* score (*M* = 1.89, *SD* = 0.79) that was significantly above zero, $t(57) = 21.15$, $p < .001$. The younger adults also had an average *d'* score (*M* = 2.03, *SD* = 0.73) that was significantly above zero, $t(55) = 17.99$, $p < .001$. The two-way ANOVA for the *d'* scores showed no main effect of age, $F(1,113) = 0.877$, $p = .351$, indicating the two groups had similar *d'* scores (Figure 8). The interaction between condition and age was also not significant, $F(1,110) = 1.43$, $p = .235$. Overall, both older and younger adults were able to differentiate between the previously studied faces and the novel faces by correctly identifying the previously studied faces as more familiar and the novel faces as less familiar. From the similar d' scores, I can see that the ability to discriminate between familiar and novel items is preserved in late adulthood.

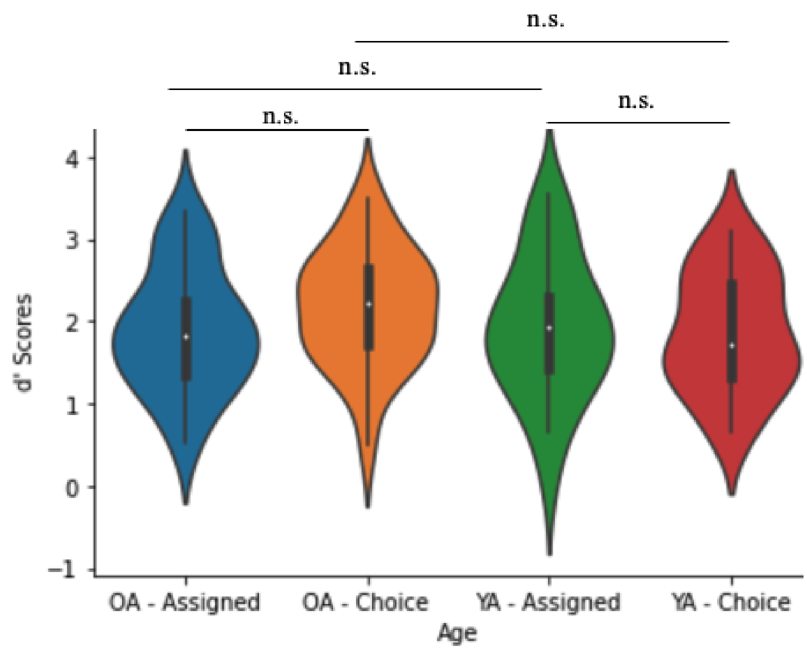


Figure 8: Violin plot for range of d' scores in familiarity discrimination for older adults (OA) and younger adults (YA) in the Choice and Assigned condition. n.s. p > .05.

Another way to ensure there is validity in the subjective familiarity ratings was to compare the average familiarity rating for each face type. A two-way between-subjects ANOVA was also conducted to compare the average familiarity ratings for the previously studied faces between the two conditions and the two age groups (Figure 8). There was no significant main effect of condition for the average familiarity rating for the previously shown faces (Choice: M = 4.5, SD = 0.77; Assigned: M = 4.48, SD = 0.74), $F(1,113)$ = 0.016, p = .899. The main effect of age was not significant (Older adults: M = 4.61, SD = 0.67; Younger adults: M = 4.36, SD = 0.81), $F(1,113)$ = 3.30, p = 0.072. The interaction between age and condition was not significant, $F(1,113)$ = 0.032, p = .859.

4.2.3 Preserved relationship between familiarity and information-seeking behaviour

A crucial comparison is the average number of previously studied faces presented during the exploration phase between the two conditions. It is crucial that participants in both conditions saw the same number of previously studied faces during the exploration phase because the final recall test consisted only of the faces shown during the initial encoding phase. One condition in which participants saw more previously studied faces during the exploration phase than the other condition could explain a difference between accuracy rates in the final recall test. There was a significant main effect of condition for the number of previously studied faces shown during the exploration phase (Choice: *M* = 34.1, *SD* = 9.91; Assigned: *M* = 31.3, *SD* = 5.34), $F(1,113) = 4.02$, $p = .047$. The main effect of age was not significant (Older adults: *M* = 33.7, *SD* = 7.88; Younger adults: *M* = 31.5, *SD* = 7.95), $F(1,113) = 2.58$, $p = .111$. There was also a significant interaction between age and condition, $F(1,113) = 5.17$, $p = .025$. As can be seen in Figure 9, the older adults in the Choice condition restudied the greatest number of previously studied faces out of all the conditions while the other three conditions saw similar numbers. This pattern is in line with the findings from Experiment 1 that showing that older adults demonstrate a stronger preference for familiar items than the younger adults. Although the number differed statistically across conditions and age groups, it is sufficiently similar to warrant comparison of the critical experimental conditions in both age groups.

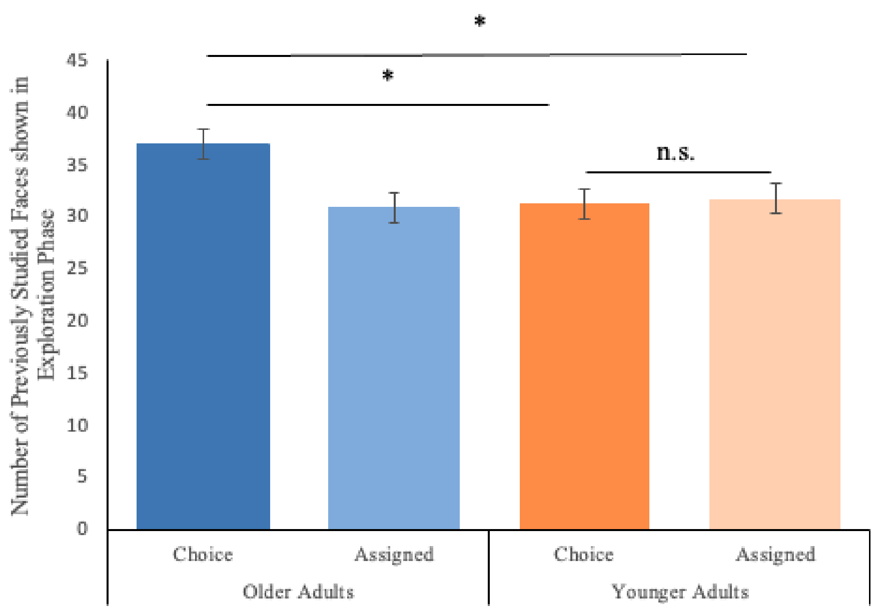


Figure 9: Comparison of the number of previously studied faces shown during the exploration phase for the older and younger adults in the Choice and Assigned conditions. * p < .05. n.s. p > .05.

4.2.4 Results from the final recall test

The

central aim of the current study was to investigate whether there are learning benefits associated with familiarity-induced curiosity and if so, whether these are comparable for younger and older adults. It was predicted that following one's own curiosity to select items to relearn would significantly improve individuals' memory for the explored items compared to those who did not have the opportunity to follow their curiosity during relearning. When analyzing the results, I can first compare the overall accuracy rates in the final recall test using a two-way ANOVA (Figure 10). There was a significant main effect of condition, where the average accuracy rate was significantly higher in the Choice condition (M = 39.3%, SD = 20.3%) compared to the Assigned condition (M = 30.1%, SD = 20.0%), $F(1, 113) = 6.12$, $p = .015$. There was no main effect of age (Older Adults: M = 31.7%, SD = 19.2%; Young Adults: M = 37.4%, SD = 21.7%), $F(1, 113) = 2.16$, $p = .144$. The interaction between condition and age was not significant for the overall accuracy in the final recall test, $F(1, 113) = 1.65$, $p = .201$.

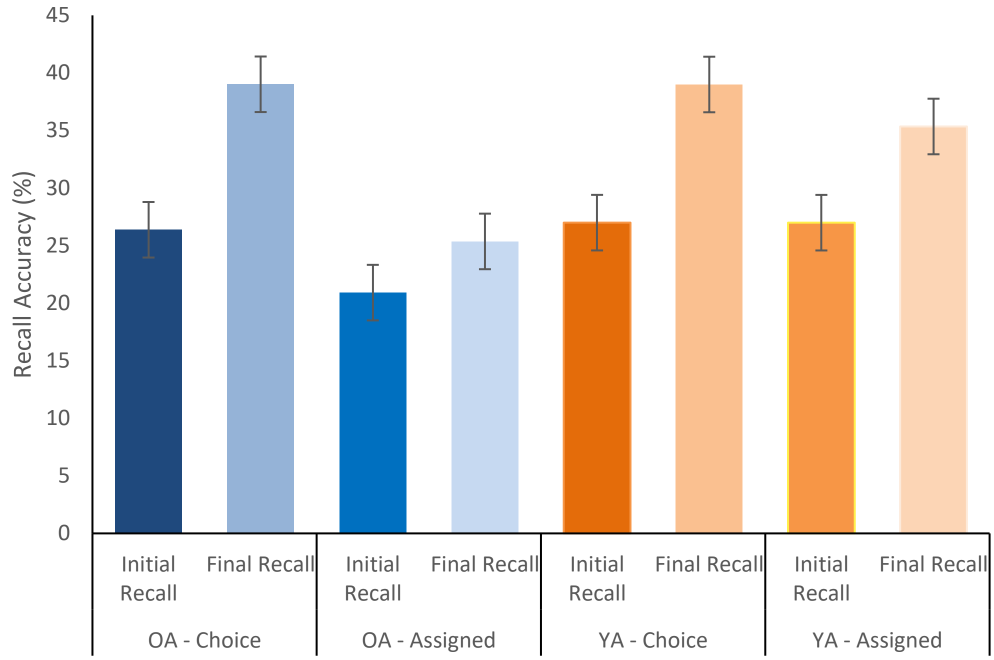


Figure 10: Difference in recall accuracy between initial recall test and final recall test for all four groups.

Another way I can look at the effect of agency on the curiosity-induced learning benefits is by comparing the improvement in recall from the initial recall test to the final recall test. The accuracy rates for the initial recall test were originally scored out of 104 trials, however, only 52 of them were previously studied. To make a valid comparison between the two recall tests, the overall number of correct names for the initial recall performance was re-scored as a proportion out of 52 trials for this analysis. The difference between the accuracy rates of the two recall tests was calculated by subtracting the accuracy score on the initial test from the accuracy score on the final recall test for each participant. A two-way ANOVA then compared the difference in recall scores for each group. There was a significant main effect of condition, where the difference in the recall rates was significantly greater in the Choice condition (M = 12.6%, SD = 11.0%) than the Assigned condition (M = 6.30%, SD = 7.52%), $F(1,113) = 13.13$, $p < .001$. There was no main effect of age (Older Adults: M = 8.27%, SD = 7.84%; Young Adults: M = 10.4%, SD = 11.6%), $F(1,113) = 1.30$, $p = .256$. The interaction between age and condition was also not significant, $F(1,113) = 1.37$, $p = .245$. The significant main effect of condition shows that those who had agency in the exploration phase benefitted significantly more from the relearning of the face-name pairs they were curious about compared to those who were assigned names for relearning.

4.3 Discussion

Previous studies have shown a general learning benefit for older and younger adults when individuals are in a state of high curiosity (Galli et al., 2018; Gruber et al., 2014; McGillivray et al., 2015). These past studies have used trivia questions to investigate how curiosity can create learning benefits for the semantic information as well as incidentally learned faces. The current study expands on the existing literature by addressing the curiosity-driven memory benefits for episodic information. The behavioural paradigm used in Experiment 2 was designed to provide participants with the opportunity to relearn information either by choice or through assignment. I was then able to look at whether allowing participants to follow their own curiosity to select items to relearn would lead to an increase in the learning benefit. In Experiment 1, I observed that younger and older adults tend to seek out information they could not recall for items that were more familiar to them. This finding was replicated among the participants in the Choice condition as the Choice condition was identical to Experiment 1. The key aim for Experiment 2 was to determine whether the act of seeking out the information that one is curious about can lead to improved recall during relearning. Participants in both the Choice and Assigned condition benefited from relearning the previously studied face-name pairs, however, the participants in the Choice condition had a greater improvement in accuracy from the first recall test to the final recall test compared to the Assigned condition. The Choice condition group also had an overall higher recall accuracy rate in the final test compared to the Assigned group. These findings were all observed in the context of unimpaired familiarity discrimination in older adults.

The paradigm of the current study was identical between the two conditions aside from the exploration phase. With that, the data from the tasks in the phases leading up to the exploration phase should not be significantly different between the two conditions. The initial recall test accuracy, the *d'* prime scores, the average familiarity ratings, and the correlation between the recall RT and the subjective familiarity ratings were compared between the two conditions. None of these measures differed between the two conditions which demonstrates the experimental set-up successfully controlled for all aspects of the procedure to ensure the reason for a difference in recall was related to having the opportunity to follow one's own curiosity. Although the older adults in the Choice condition had a significantly greater number of previously studied faces presented to them during the exploration phase compared to the other three groups, there was no main effect of age and no significant interaction between age and condition. This suggests that the older adults in the Choice condition who relearned more of the previously studied faces did not skew the results in the final recall test. The greater number of familiar faces selected to relearn among the older adults matches the findings from Experiment 1 that suggests older adults may have a stronger preference for the familiar faces. If the current study was replicated in the future, the group of older adults in the Assigned condition could be shown a greater number of previously studied faces to match that of the older adults in the Choice condition. I would not predict the results from a study with this change to have significantly different results than the current study. Further analyses of the current data that focus only on final recall accuracy for previously studied items that were presented for relearning could provide more clarity.

Overall, the key finding from the current study was the significant difference between the final recall scores of the Assigned condition versus the Choice condition. Additionally, the improvement from the initial recall test to the final recall test was significantly higher for those in the Choice condition compared to those in the Assigned condition. Not only were these results shown in the group of younger adults, but also within the group of older adults. This pattern of results suggests that having an opportunity to follow familiarity-driven curiosity following unsuccessful recall offers significant learning benefit for both younger adults and healthy, older adults.

Chapter 4

5 Discussion

Across the two experiments of the current thesis, there were three key aims. First, I aimed to replicate the findings from the study by Brooks and colleagues (2023) which demonstrated a positive relationship between subjective familiarity ratings for faces in the context of unsuccessful name recall and subsequent information-seeking behaviour. Additionally, I aimed to determine whether the same relationship was preserved in a population of older adults. Our third goal was to determine whether acting on the curiosity induced by the unsuccessful recall of the names associated with familiar faces could provide benefits for the relearning of those names. Results from Experiment 1 demonstrated the same positive relationship between familiarity and choices in information-seeking behaviour in the group of younger adults that was reported in the study by Brooks and colleagues (2023). Critically, the findings of the current study also demonstrated a preservation of this relationship throughout late adulthood as the older adults tested had a similar, if not more pronounced, positive relationship between feelings of familiarity and information-seeking. This pattern was observed in the context of unimpaired familiarity discrimination in older adults. In Experiment 2, I found that giving participants an opportunity to follow their own curiosity when exploring information that could not be recalled led to greater improvements in overall recall accuracy than exposure to such information under conditions in which curiosity could not be acted upon during relearning. This pattern of findings was observed for both the older and younger adults.

Results from both Experiment 1 and Experiment 2 demonstrated a preservation of familiarity discrimination among the older and younger participants. The familiarity ratings were compared using two different methods for both age groups in both experiments. The first method compared the average familiarity ratings for the previously studied to the novel faces to replicate the analysis from Brooks et al. (2023). The second method used a signal detection calculation as seen in previous studies that have looked at familiarity and recognition memory (for review see Koen & Yonelinas, 2014). Both methods revealed comparable accuracy in the familiarity judgments for both older and younger adults in both Experiment 1 and Experiment 2. These results demonstrate preserved discrimination between previously studied faces and novel faces based on their familiarity in older adults in situations in which corresponding names cannot be recalled. Even though many types of memory and memory retrieval are affected by aging (Bastin & Van der Linden, 2003; Craik & McDowd, 1987; Danckert & Craik, 2013a), familiarity accuracy has been shown to be relatively well preserved in numerous other studies (Bartlett & Fulton, 1991; Bastin & Van der Linden, 2003; for review see Koen & Yonelinas, 2014). It was critical to first demonstrate the preservation of familiarity discrimination in older adults in the current experimental paradigm as one of the goals of this work was to determine whether familiarity-induced curiosity could be leveraged to create learning benefits following unsuccessful name recall with familiar faces.

An unexpected finding that was observed in both experiments was the lack of a clear recall deficit for the previously learned names in older adults as compared to younger adults. This was unexpected as such recall deficits have been commonly reported in the broader memory literature (Danckert & Craik, 2013a; Rhodes et al., 2019). A possible explanation for this outcome relates to the fact that the current data were collected online. Recent work has found that conducting studies online can reduce the difference in recall accuracy between younger and older adults (Swirsky & Spaniol, 2023). Out of all the different online recruitment platforms available (such as Prolific, MTurk, SONA, etc.), Prolific has been found to have the best quality data and the most representative samples (Douglas et al., 2023; Peer et al., 2021). With that in mind, it is unlikely that the lack of a significant recall deficit between the two age groups observed here is specifically tied to the platform employed to collect data. A main issue associated with testing both older and younger adults in an online study, however, is that the older adults who participate tend to be more technologically advanced than the typical older adult population sampled in studies that collect data in person in the lab. When an older adult is more accustomed to using technology, they have been reported to see many benefits, including improved episodic memory and processing speed (Chan et al., 2016). Additionally, it is worth noting that the older adults in the current study had an average educational attainment (M = 16.04, SD = 3.71) that was higher than the Canadian national average for all adults (M = 14.00; World Economics, n.d.). According to Kaufman and colleagues (2015), educational attainment is positively correlated with verbal episodic memory, processing speed, and verbal fluency. The high educational levels along with the technology abilities in the older adult group may explain the recall accuracy rates that were higher than I originally anticipated. In general, online studies tend to have lower quality data compared to in-person studies (Greene & Naveh-Benjamin, 2022). Against this background, it is also possible that the younger adults tested here were less engaged in the task administered than those that have been sampled in the larger literature based on in-person testing. This lack of engagement may have played out specifically in the recall test rather than the familiarity-based recognition because of the level of effort required for the former task. Previous work suggests that recall tests require more effort than recognition tests (Bjork, 1975). This sample characteristic may have resulted in lower recall accuracy results than anticipated. Together, a scenario in which the situation where the older adults performed better than expected combined with the younger adults performing worse than expected could explain the lack of significant difference between the recall rates of the two age groups.

Building on the study by Brooks and colleagues (2023), I explored the relationship between the subjective familiarity ratings and subsequent information-seeking behaviour in a group of younger and older adults. The results of Experiment 1 demonstrated a positive relationship in the group of younger adults, which nicely replicated the findings from Brooks et al. (2023), as well as the older adults, which was a novel finding. Following an unsuccessful recall attempt, participants in both the older and younger adult groups were more likely to seek out the associated name for a face they had previously rated as more familiar following an unsuccessful recall attempt. Seeking out the name associated with a familiar face suggests it is familiarity rather than novelty that is promoting curiosity under these circumstances. Although the original definition of curiosity emphasized that curiosity is the desire for new information (Berlyne, 1954), the results from the current study along with other recent work (see Brooks et al., 2021, 2023; Metcalfe et al., 2017) suggest that such links between novelty and curiosity are not ubiquitous. The results from Experiment 1 can be explained under the theoretical frameworks that connect curiosity to its role in motivating information-seeking in an effort to fill information gaps (Loewenstein, 1994; Metcalfe et al., 2020). According to the RPL theory, an unsuccessful recall attempt is critical for identifying an information gap and the theory also states that information that has the potential to close the gap with ease induces the highest levels of curiosity (Metcalfe et al., 2020). The behavioural paradigm in the current study provided a perfect opportunity to induce high levels of curiosity, when defined that way, as recall attempts were followed by a familiarity judgment. Faces from trials with unsuccessful recall that were given a higher subjective familiarity rating were more likely to be selected to study in the exploration phase compared to those given a lower rating. Even though curiosity is clearly induced by novelty under many circumstances (Berlyne, 1950; Kashdan & Silvia, 2009; Schomaker & Meeter, 2015), the current study adds to an emerging body of work demonstrating that familiarity, when combined with unsuccessful recall, can reverse such tendencies.

A key finding from Experiment 2 was the significant difference in recall scores between the participants in the Assigned condition and the Choice condition. Although both groups benefited from relearning the names, the participants who were offered the opportunity to follow their own curiosity in selecting the information to be relearned saw a greater improvement from the initial recall test to the final recall test compared to the participants who were assigned the names to relearn. These findings were not only demonstrated in the group of younger adults, but also within the group of older adults. Previous work has shown there are curiosity-driven memory benefits for target information (Kang et al., 2008) as well as incidentally learned information (Galli et al., 2018; Gruber et al., 2014) for both older and younger adults (McGillivray et al., 2015). The findings from the current study expand on the existing literature by demonstrating that curiosity can even drive learning benefits when information has previously been encountered and is already familiar. Giving individuals the opportunity to follow their own curiosity significantly increased the degree to which relearning improved their recall accuracy. These benefits allowed a group of older adults to significantly improve their recall accuracy for episodic information. Understanding this benefit can lead to many future studies that could help older adults overcome a main memory deficit (Craik & McDowd, 1987).

5.1 Limitations

One limitation of the current research is that the experiments were conducted online. Although conducting the experiment online allows for data collection of geographically diverse samples around the world, recruitment is limited to those who have access to and the ability to use a computer. Older adults who frequently use computers have been found to have increased processing speed and episodic memory as compared to individuals who do not engage in such use (Chan et al., 2016). As mentioned previously, the higher-than-expected performance from the older adults combined with the poorer than expected performance from the younger adults may have led to the lack of an age-related recall deficit in the current study. It would be beneficial to conduct a similar experiment in-person in order to examine whether the typical recall deficit observed in older individuals emerges in the current paradigm under such circumstances and, critically, whether the impact of familiarity on curiosity and relearning are the same. Notably, in Experiment 1, the reported pattern was still found even when subsamples of younger and older adults who showed the typical difference in recall performance were compared. This finding makes me optimistic that the curiosity and learning benefits I describe here are not tied to unusually high recall performance in older adults.

In Experiment 2, I saw an increase in the learning benefit when participants had the opportunity to select the items they wished to relearn. I examined the impact of curiosity on relearning information by manipulating agency. In one condition, participants were given the opportunity to select information to relearn and the other condition assigned the information to relearn to the participants without active selection. The recall accuracies were compared between the two conditions, and I found those in the Choice condition had a greater improvement in their recall. I interpret this benefit to be a result of providing the participants with the opportunity to follow their own curiosity, however, it may arise from an effect that is specific to agency. Agency refers to when an individual feels as though they are in control of their own actions and the associated consequences (Moore, 2016). Agency may exert influences on learning through mechanisms other than curiosity as well, including through the decision-making process or the generation of predictions (Friston et al., 2013). At the neural level, the curiosity-driven memory benefits may stem from the dopaminergic reward system which has also been tied to agency Ashby et al., 2023; Render & Jansen, 2019). A study by Ashby and colleagues (2023) found that increases in agency leads to a disinhibition of the dopamine system which increases the number of active dopamine neurons in the ventral tegmental area. Connecting these findings to the results from Experiment 2, it is unclear whether it is an increase afforded through agency, through curiosity, or through both that might have produced the benefit for learning and subsequent recall.

5.2 Future Directions

Considering the learning benefits that arose from having the opportunity to follow one's own curiosity in the relearning of face-name associations were significant in both younger adults and healthy older adults, there are many interesting future directions. As mentioned previously, there is a difference in age-related memory changes for semantic information and episodic information, with semantic memory being more resistant to performance decline in older adults (Allen et al., 2002). Now that I have revealed initial evidence to suggest that I can produce benefits for curiosity-driven relearning of names associated with familiar faces in the context of episodic memory, I can also examine whether this benefit is maintained for semantic stimuli, such as for the names of celebrities that cannot be recalled even though they may have been encountered tens or hundreds of times. Previous work on curiosity has used trivia questions to study the curiosity-driven memory benefits for semantic information in younger and older adults (Galli et al., 2018; Gruber et al., 2014; McGillivray et al., 2015). Using celebrity face-name pairs as semantic stimuli would provide an opportunity to investigate whether the same curiosity-driven memory found using arbitrary face-name pairs in an experimental setting transfer to more real-world situations.

Another interesting direction for future research would connect the existing literature on the dopamine-reward pathway throughout aging to the preserved memory benefits of curiosity found in our paradigm. Understanding whether and how the dopamine pathway may provide the same enhanced learning benefit in the older adults as is found in younger adults is an important topic to be explored, in particular considering that decline of some dopamine capabilities have been reported with aging (Düzel et al., 2010; Karrer et al., 2017; Morgan, 1987). One method that could be used to do this is by probing task-related brain activation using functional Magnetic Resonance Imaging (fMRI). Previous studies have shown that the greatest activation for the reward pathway is found in the anticipation of the rewarding information rather than once the rewarding information is presented (Gruber et al., 2014; Kang et al., 2008). To our knowledge, this pattern has not been studied in older adults yet, so it is important to investigate whether the size of the activation and the timing of the activation is similar in older adults as it is in younger adults. Another method that would offer an interesting approach to this topic is using the fairly new technology that uses neuromelanin-sensitive MRI (NM-MRI) as a way to quantify dopamine function (Cassidy et al., 2019). Thus far, research that has used NM-MRI has focused on neuropsychiatric diseases and is beginning to look at dopamine in patients with Parkinson’s disease (see Cassidy et al., 2019; Depierreux et al., 2021; Horga et al., 2021; Wengler et al., 2021). Expanding the use of NM-MRI would provide the opportunity to compare dopaminergic function in the younger and older adults and investigate the specific role of dopamine in the curiosity-driven memory benefits.

5.3 Conclusions

Results from the current experiment revealed a preservation of the relationship between subjective familiarity ratings and subsequent information-seeking behaviour in older adults and younger adults. Contrary to the widely accepted definition that curiosity stems from an intrinsic desire for new information (Berlyne, 1954), these results demonstrate that following an unsuccessful recall attempt both older and younger adults are more likely to seek-out the names associated with a familiar faces for exploration rather than a novel names. The second experiment demonstrated that this familiarity-induced curiosity can lead to improved recall accuracy in a follow-up memory test. Furthermore, participants who were given an opportunity to follow their own curiosity to relearn the names associated with familiar faces had a greater improvement from the first recall test to the final recall test compared to those who did not have such an opportunity. This experiment revealed that familiarity-based curiosity can indeed be leveraged to overcome recall problems in younger adults, as well as in older adults. These results provide many new directions for follow-up research with respect to the generalizability of the behavioural findings observed as well as with respect to underlying neural mechanisms.

References

Average years of schooling. World Economics. (n.d.). https://www.worldeconomics.com/Indicator-Data/ESG/Social/Mean-Years-of-Schooling/

Abir, Y., Marvin, C. B., Van Geen, C., Leshkowitz, M., Hassin, R. R., & Shohamy, D. (2022). An energizing role for motivation in information-seeking during the early phase of the COVID-19 pandemic. *Nature Communications*, *13*(1), 2310. https://doi.org/10.1038/s41467-022-30011-5

Allen, P. A., Sliwinski, M., Bowie, T., & Madden, D. J. (2002). Differential Age Effects in Semantic and Episodic Memory. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *57*(2), P173–P186. https://doi.org/10.1093/geronb/57.2.P173

Ashby, F. G., Zetzer, H. A., Conoley, C. W., & Pickering, A. (2023). *Just Do It: A Neuropsychological Theory of Agency, Cognition, Mood, and Dopamine* [Preprint]. PsyArXiv. https://doi.org/10.31234/osf.io/rtmfv

Bartlett, J. C., & Fulton, A. (1991). Familiarity and recognition of faces in old age. *Memory & Cognition*, *19*(3), 229–238. https://doi.org/10.3758/BF03211147

Bastin, C., & Van der Linden, M. (2003). The contribution of recollection and familiarity to recognition memory: A study of the effects of test format and aging. *Neuropsychology*, *17*(1), 14–24. https://doi.org/10.1037/0894-4105.17.1.14

Benjamin, B. J. (1987). Using Simulation Activities to Understand Elderly Aphasic Speech Disorders. *Gerontology & Geriatrics Education*, *6*(4), 17–25. https://doi.org/10.1300/J021v06n04_03

Berlyne, D. (1950). Novelty and curiosity as determinants of exploratory behaviour. *British Journal of Psychology, 41*, 68–80.

Berlyne, D. E. (1954). A THEORY OF HUMAN CURIOSITY. *British Journal of Psychology. General Section*, *45*(3), 180–191. https://doi.org/10.1111/j.2044-8295.1954.tb01243.x

Braskie, M. N., Wilcox, C. E., Landau, S. M., O'Neil, J. P., Baker, S. L., Madison, C. M., Kluth, J. T., & Jagust, W. J. (2008). Relationship of Striatal Dopamine Synthesis Capacity to Age and Cognition. *The Journal of Neuroscience*, *28*(52), 14320–14328. https://doi.org/10.1523/JNEUROSCI.3729-08.2008

Bromberg-Martin, E. S., Matsumoto, M., & Hikosaka, O. (2010). Dopamine in Motivational Control: Rewarding, Aversive, and Alerting. *Neuron*, *68*(5), 815–834. https://doi.org/10.1016/j.neuron.2010.11.022

Brooks, G., Whitehead, H., & Köhler, S. (2023). When familiarity not novelty motivates information-seeking behaviour. *Scientific Reports, 13*(1), 5201. https://doi.org/10.1038/s41598-023-31953-6

Brooks, G., Yang, H., & Köhler, S. (2021). Feeling-of-knowing experiences breed curiosity. *Memory*, *29*(2), 153–167. https://doi.org/10.1080/09658211.2020.1867746

Cassidy, C. M., Zucca, F. A., Girgis, R. R., Baker, S. C., Weinstein, J. J., Sharp, M. E., Bellei, C., Valmadre, A., Vanegas, N., Kegeles, L. S., Brucato, G., Kang, U. J., Sulzer, D., Zecca, L., Abi-Dargham, A., & Horga, G. (2019). Neuromelanin-sensitive MRI as a noninvasive proxy measure of dopamine function in the human brain. *Proceedings of the National Academy of Sciences*, *116*(11), 5108–5117. https://doi.org/10.1073/pnas.1807983116

Cervera, R. L., Wang, M. Z., & Hayden, B. Y. (2020). Systems neuroscience of curiosity. *Current Opinion in Behavioral Sciences*, *35*, 48–55. https://doi.org/10.1016/j.cobeha.2020.06.011

Chan, M. Y., Haber, S., Drew, L. M., & Park, D. C. (2016). Training Older Adults to Use Tablet Computers: Does It Enhance Cognitive Function? *The Gerontologist*, *56*(3), 475–484. https://doi.org/10.1093/geront/gnu057

Charles, S. T., Mather, M., & Carstensen, L. L. (2003). Aging and emotional memory: The forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General*, *132*(2), 310–324. https://doi.org/10.1037/0096-3445.132.2.310

Chu, L., & Fung, H. H. (2022). Age Differences in State Curiosity: Examining the Role of Personal Relevance. *Gerontology*, *68*(3), 321–329. https://doi.org/10.1159/000516296

Craik, F. I. M., & McDowd, J. M. (1987). Age differences in recall and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *13*(3), 474–479. https://doi.org/10.1037/0278-7393.13.3.474

Crook, T. H., & West, R. L. (1990). Name recall performance across the adult life-span. *British Journal of Psychology*, *81*(3), 335–349. https://doi.org/10.1111/j.2044-8295.1990.tb02365.x

Danckert, S. L., & Craik, F. I. M. (2013a). Does aging affect recall more than recognition memory? *Psychology and Aging*, *28*(4), 902–909. https://doi.org/10.1037/a0033263

Danckert, S. L., & Craik, F. I. M. (2013b). Does aging affect recall more than recognition memory? *Psychology and Aging*, *28*(4), 902–909. https://doi.org/10.1037/a0033263

Depierreux, F., Parmentier, E., Mackels, L., Baquero, K., Degueldre, C., Balteau, E., Salmon, E., Phillips, C., Bahri, M. A., Maquet, P., & Garraux, G. (2021). Parkinson’s disease multimodal imaging: F-DOPA PET, neuromelanin-sensitive and quantitative iron-sensitive MRI. *Npj Parkinson’s Disease*, *7*(1), 57. https://doi.org/10.1038/s41531-021-00199-2

Douglas, B. D., Ewell, P. J., & Brauer, M. (2023). Data quality in online human-subjects research: Comparisons between MTurk, Prolific, CloudResearch, Qualtrics, and SONA. *PLOS ONE*, *18*(3), e0279720. https://doi.org/10.1371/journal.pone.0279720

Düzel, E., Bunzeck, N., Guitart-Masip, M., & Düzel, S. (2010). NOvelty-related Motivation of Anticipation and exploration by Dopamine (NOMAD): Implications for healthy aging. *Neuroscience & Biobehavioral Reviews*, *34*(5), 660–669. https://doi.org/10.1016/j.neubiorev.2009.08.006

Elsworth, J. D., & Roth, R. H. (2009). Dopamine. In *Encyclopedia of Neuroscience* (pp. 539–547). Elsevier. https://doi.org/10.1016/B978-008045046-9.00683-5

Friston, K., Schwartenbeck, P., FitzGerald, T., Moutoussis, M., Behrens, T., & Dolan, R. J. (2013). The anatomy of choice: Active inference and agency. *Frontiers in Human Neuroscience*, *7*. https://doi.org/10.3389/fnhum.2013.00598

Galli, G., Sirota, M., Gruber, M. J., Ivanof, B. E., Ganesh, J., Materassi, M., Thorpe, A., Loaiza, V., Cappelletti, M., & Craik, F. I. M. (2018). Learning facts during aging: The benefits of curiosity. *Experimental Aging Research*, *44*(4), 311–328. https://doi.org/10.1080/0361073X.2018.1477355

Gottlieb, J., Oudeyer, P.-Y., Lopes, M., & Baranes, A. (2013). Information-seeking, curiosity, and attention: Computational and neural mechanisms. *Trends in Cognitive Sciences*, *17*(11), 585–593. https://doi.org/10.1016/j.tics.2013.09.001

Greene, N. R., & Naveh-Benjamin, M. (2022). Online experimentation and sampling in cognitive aging research. *Psychology and Aging*, *37*(1), 72–83. https://doi.org/10.1037/pag0000655

Grossnickle, E. M. (2016). Disentangling Curiosity: Dimensionality, Definitions, and Distinctions from Interest in Educational Contexts. *Educational Psychology Review*, *28*(1), 23–60. https://doi.org/10.1007/s10648-014-9294-y

Gruber, M. J., Gelman, B. D., & Ranganath, C. (2014). States of Curiosity Modulate Hippocampus-Dependent Learning via the Dopaminergic Circuit. *Neuron*, *84*(2), 486–496. https://doi.org/10.1016/j.neuron.2014.08.060

Gruber, M. J., & Ranganath, C. (2019). How Curiosity Enhances Hippocampus-Dependent Memory: The Prediction, Appraisal, Curiosity, and Exploration (PACE) Framework. *Trends in Cognitive Sciences*, *23*(12), 1014–1025. https://doi.org/10.1016/j.tics.2019.10.003

Haitas, N., Amiri, M., Wilson, M., Joanette, Y., & Steffener, J. (2021). Age-preserved semantic memory and the CRUNCH effect manifested as differential semantic control networks: An fMRI study. *PLOS ONE*, *16*(6), e0249948. https://doi.org/10.1371/journal.pone.0249948

Hidi, S. E., & Renninger, K. A. (2020). On educating, curiosity, and interest development. *Current Opinion in Behavioral Sciences*, *35*, 99–103. https://doi.org/10.1016/j.cobeha.2020.08.002

Horga, G., Wengler, K., & Cassidy, C. M. (2021). Neuromelanin-Sensitive Magnetic Resonance Imaging as a Proxy Marker for Catecholamine Function in Psychiatry. *JAMA Psychiatry*, *78*(7), 788. https://doi.org/10.1001/jamapsychiatry.2021.0927

Kaasinen, V., & Rinne, J. O. (2002). Functional imaging studies of dopamine system and cognition in normal aging and Parkinson's disease. *Neuroscience & Biobehavioral Reviews*, *26*(7), 785–793. https://doi.org/10.1016/S0149-7634(02)00065-9

Kang, M. J., Hsu, M., Krajbich, I. M., Loewenstein, G. F., McClure, S. M., Wang, J. T., & Camerer, C. F. (2008). The Wick in the Candle of Learning: Epistemic Curiosity Activates Reward Circuitry and Enhances Memory. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1308286

Karrer, T. M., Josef, A. K., Mata, R., Morris, E. D., & Samanez-Larkin, G. R. (2017). Reduced dopamine receptors and transporters but not synthesis capacity in normal aging adults: A meta-analysis. *Neurobiology of Aging*, *57*, 36–46. https://doi.org/10.1016/j.neurobiolaging.2017.05.006

Kashdan, T. B., & Silvia, P. J. (2009). Curiosity and Interest: The Benefits of Thriving on Novelty and Challenge. In S. J. Lopez & C. R. Snyder (Eds.), *The Oxford Handbook of Positive Psychology* (pp. 366–374). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780195187243.013.0034

Kashdan, T. B., Stiksma, M. C., Disabato, D. J., McKnight, P. E., Bekier, J., Kaji, J., & Lazarus, R. (2018). The five-dimensional curiosity scale: Capturing the bandwidth of curiosity and identifying four unique subgroups of curious people. *Journal of Research in Personality*, *73*, 130–149. https://doi.org/10.1016/j.jrp.2017.11.011

Kinugawa, K., Schumm, S., Pollina, M., Depre, M., Jungbluth, C., Doulazmi, M., Sebban, C., Zlomuzica, A., Pietrowsky, R., Pause, B., Mariani, J., & Dere, E. (2013). Aging-related episodic memory decline: Are emotions the key? *Frontiers in Behavioral Neuroscience*, *7*. https://doi.org/10.3389/fnbeh.2013.00002

Koen, J. D., & Yonelinas, A. P. (2014). The Effects of Healthy Aging, Amnestic Mild Cognitive Impairment, and Alzheimer's Disease on Recollection and Familiarity: A Meta-Analytic Review. *Neuropsychology Review*, *24*(3), 332–354. https://doi.org/10.1007/s11065-014-9266-5

Koen, J. D., & Yonelinas, A. P. (2016). Recollection, not familiarity, decreases in healthy ageing: Converging evidence from four estimation methods. *Memory*, *24*(1), 75–88. https://doi.org/10.1080/09658211.2014.985590

Lamnina, M., & Chase, C. C. (2019). Developing a thirst for knowledge: How uncertainty in the classroom influences curiosity, affect, learning, and transfer. *Contemporary Educational Psychology*, *59*, 101785. https://doi.org/10.1016/j.cedpsych.2019.101785

LaPlume, A. A., Anderson, N. D., McKetton, L., Levine, B., & Troyer, A. K. (2022). When I'm 64: Age-Related Variability in Over 40,000 Online Cognitive Test Takers. *The Journals of Gerontology: Series B*, *77*(1), 104–117. https://doi.org/10.1093/geronb/gbab143

LaPlume, A. A., McKetton, L., Anderson, N. D., & Troyer, A. K. (2022). Sex differences and modifiable dementia risk factors synergistically influence memory over the adult lifespan. *Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring*, *14*(1), e12301. https://doi.org/10.1002/dad2.12301

Lisman, J. E., & Grace, A. A. (2005). The Hippocampal-VTA Loop: Controlling the Entry of Information into Long-Term Memory. *Neuron*, *46*(5), 703–713. https://doi.org/10.1016/j.neuron.2005.05.002

Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin*, *116*(1), 75–98. https://doi.org/10.1037/0033-2909.116.1.75

McGillivray, S., Murayama, K., & Castel, A. D. (2015). Thirst for knowledge: The effects of curiosity and interest on memory in younger and older adults. *Psychology and Aging*, *30*(4), 835–841. https://doi.org/10.1037/a0039801

Metcalfe, J., Schwartz, B. L., & Bloom, P. A. (2017). The tip-of-the-tongue state and curiosity. *Cognitive Research: Principles and Implications*, *2*(1), 31. https://doi.org/10.1186/s41235-017-0065-4

Metcalfe, J., Schwartz, B. L., & Eich, T. S. (2020). Epistemic curiosity and the region of proximal learning. *Current Opinion in Behavioral Sciences*, *35*, 40–47. https://doi.org/10.1016/j.cobeha.2020.06.007

Moore, J. W. (2016). What Is the Sense of Agency and Why Does it Matter? *Frontiers in Psychology*, *7*. https://doi.org/10.3389/fpsyg.2016.01272

Morgan, D. G. (1987). The dopamine and serotonin systems during aging in human and rodent brain. A brief review. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, *11*(2–3), 153–157. https://doi.org/10.1016/0278-5846(87)90053-4

Peer, E., Rothschild, D., Gordon, A., Evernden, Z., & Damer, E. (2021). Data quality of platforms and panels for online behavioral research. *Behavior Research Methods*, *54*(4), 1643–1662. https://doi.org/10.3758/s13428-021-01694-3

Peirce, J., Gray, J. R., Simpson, S., MacAskill, M., Höchenberger, R., Sogo, H., Kastman, E., & Lindeløv, J. K. (2019). PsychoPy2: Experiments in behavior made easy. *Behavior Research Methods*, *51*(1), 195–203. https://doi.org/10.3758/s13428-018-01193-y

Perrotin, A., Isingrini, M., Souchay, C., Clarys, D., & Taconnat, L. (2006). Episodic feeling-of-knowing accuracy and cued recall in the elderly: Evidence for double dissociation involving executive functioning and processing speed. *Acta Psychologica*, *122*(1), 58–73. https://doi.org/10.1016/j.actpsy.2005.10.003

Read, S., Comas-Herrera, A., & Grundy, E. (2020). Social Isolation and Memory Decline in Later-life. *The Journals of Gerontology: Series B*, *75*(2), 367–376. https://doi.org/10.1093/geronb/gbz152

Render, A., & Jansen, P. (2019). Dopamine and sense of agency: Determinants in personality and substance use. *PLOS ONE*, *14*(3), e0214069. https://doi.org/10.1371/journal.pone.0214069

Rhodes, S., Greene, N. R., & Naveh-Benjamin, M. (2019). Age-related differences in recall and recognition: A meta-analysis. *Psychonomic Bulletin & Review*, *26*(5), 1529–1547. https://doi.org/10.3758/s13423-019-01649-y

Rönnlund, M., Nyberg, L., Bäckman, L., & Nilsson, L.-G. (2005). Stability, Growth, and Decline in Adult Life Span Development of Declarative Memory: Cross-Sectional and Longitudinal Data From a Population-Based Study. *Psychology and Aging*, *20*(1), 3–18. https://doi.org/10.1037/0882-7974.20.1.3

Sakaki, M., Yagi, A., & Murayama, K. (2018). Curiosity in old age: A possible key to achieving adaptive aging. *Neuroscience & Biobehavioral Reviews*, *88*, 106–116. https://doi.org/10.1016/j.neubiorev.2018.03.007

Schomaker, J., & Meeter, M. (2015). Short- and long-lasting consequences of novelty, deviance and surprise on brain and cognition. *Neuroscience & Biobehavioral Reviews*, *55*, 268–279. https://doi.org/10.1016/j.neubiorev.2015.05.002

Souchay, C., Isingrini, M., & Espagnet, L. (2000). Aging, episodic memory feeling-of-knowing, and frontal functioning. *Neuropsychology*, *14*(2), 299–309. https://doi.org/10.1037/0894-4105.14.2.299

Squire, L. R., Stark, C. E. L., & Clark, R. E. (2004). THE MEDIAL TEMPORAL LOBE. *Annual Review of Neuroscience*, *27*(1), 279–306. https://doi.org/10.1146/annurev.neuro.27.070203.144130

St-Laurent, M., Abdi, H., Burianová, H., & Grady, C. L. (2011). Influence of Aging on the Neural Correlates of Autobiographical, Episodic, and Semantic Memory

Retrieval. *Journal of Cognitive Neuroscience*, *23*(12), 4150–4163. https://doi.org/10.1162/jocn_a_00079

Swirsky, L. T., & Spaniol, J. (2019). Cognitive and motivational selectivity in healthy aging. *WIREs Cognitive Science*, *10*(6). https://doi.org/10.1002/wcs.1512

Tulving, E. (1972). *Organization of Memory* (W. Donaldson & E. Tulving, Eds.). Academic Press.

Tulving, E. (2002). Episodic Memory: From Mind to Brain. *Annual Review of Psychology*, *53*(1), 1–25. https://doi.org/10.1146/annurev.psych.53.100901.135114

Wade, S., & Kidd, C. (2019). The role of prior knowledge and curiosity in learning. *Psychonomic Bulletin & Review*, *26*(4), 1377–1387. https://doi.org/10.3758/s13423-019-01598-6

Wengler, K., Ashinoff, B. K., Pueraro, E., Cassidy, C. M., Horga, G., & Rutherford, B. R. (2021). Association between neuromelanin-sensitive MRI signal and psychomotor slowing in late-life depression. *Neuropsychopharmacology*, *46*(7), 1233–1239. https://doi.org/10.1038/s41386-020-00860-z

Yonelinas, A. P. (2002). The Nature of Recollection and Familiarity: A Review of 30 Years of Research. *Journal of Memory and Language*, *46*(3), 441–517. https://doi.org/10.1006/jmla.2002.2864

Appendices

Appendix A: Multiple Choice Questions

How many experimental phases will there be during this study?

a) 1
b) 2
c) 3
d) 4

What key must you press to continue with the study after you are presented a face-name pair?

a) Y
b) No key is needed
c) 1
d) 7

What were you tasked with during the first phase of the study?

a) Memorize many names
b) Memorize many faces
c) Memorize faces and names
d) Look at faces and names but not memorize

When you were asked to judge your familiarity for faces, what rating scale were you instructed to use?

a) 1-4 rating scale
b) 0-10 rating scale
c) 1-7 rating scale
d) 1-6 rating scale

What key were you instructed to press when a blue square randomly appeared on the screen?

a) 7
b) Space
c) Y
d) 9

In the second phase of the experiment, what were you instructed to do if you could not recall the face's corresponding name?

a) Guesses were encouraged
b) Guesses were not encouraged
c) Write an animal type instead

d) Write a number instead

In the final phase of the study, how many faces were presented at a single time while you were asked to select the face whose name you wanted to see again?

a) 5
b) 4
c) 3
d) 2

In the final phase of the study, how were you instructed to select the face you wanted to be shown the name for?

a) Click on the face you would like to see the name for
b) Use the right and left arrows
c) Use the '1' key for left face and '2' key for right face
d) Double click space bar for right and single click for left

Appendix B: Additional Analyses for Experiment 1

It was expected that I would see a recall deficit among the older adults. However, in Experiment 1a, the older adults (*M* = 10.71%, *SD* = 9.11%) did not have a significantly different recall accuracy rate compared to the younger adults (*M* = 12.17%, *SD* = 9.99%), $t(67) = -0.636$, $p = .527$. In Experiment 1a, the older adults (*M* = 1.94, *SD* = 0.75) had an average *d'* score that was significantly above zero, $t(36) = 15.71$, $p < .001$. The younger adults (*M* = 1.76, *SD* = 0.98), had *d'* scores significantly above zero, $t(30) = 9.95$, $p < .001$. The two age groups did not differ in their *d'* scores in Experiment 1a, $t(66) = 0.891$, $p = 0.376$. Finally, for Experiment 1a, the Gamma correlation was significantly above zero for both the older adult group (*Mean* γ = 0.46, *SD* = 0.33; $t(36) = 8.66$, $p < .001$) and the younger adult group (*Mean* γ *= 0.33, SD =0.36;* $t(31) = 5.18$, $p < .001$). There was not a significant difference between the two age groups, *t*(67) = ,1.65 *p* = .104.

In Experiment 1b, the older adults (*M* = 12.63%, *SD* = 9.23%) also did not have a significantly different recall accuracy rate compared to the younger adults (*M* = 9.93%, *SD* = 8.92%), $t(49) = 1.05$, $p = .299$. In Experiment 1b, older adults (*M* = 2.05, *SD* = 0.93) had an average *d'* score that was significantly above zero, $t(20) = 10.10$, $p < .001$. The younger adults (*M* = 1.65, *SD* = 0.74), had *d'* scores significantly above zero, $t(29) = 12.18$, $p < .001$. The two age groups did not differ in their *d'* scores in Experiment 1b, *t*(49) = 0.1.72, *p* = 0.09. Finally, for Experiment 1b, the Gamma correlation was significantly above zero for both the older adult group (*Mean* γ = 0.59, *SD* = 0.31; $t(19) = 8.53$, $p < .001$) and the younger adult group (*Mean* γ =0.22 , *SD* = 0.39; $t(28) = 3.01$, $p = .006$). There was a significant difference between the two age groups, $t(47) = 3.59$, $p < .001$.

The results from the two experiments (1a: *M* = 12.9, *SD* = 10.4; 1b: *M* = 12.5, *SD* = 10.2), $F(1, 115) = 0.03$, $p = .862$. Recall accuracy levels were similar between the two versions of the experiment. There was no main effect of version when looking at the gamma correlations for the relationship between subjective familiarity ratings and subsequent information seeking behaviour (1a: *M* = 0.402, *SD* = 0.346; 1b: *M* = 0.362, *SD* = 0.402), $F(1, 113) = 0.360$, $p = .549$. Participants in both experimental groups had similar gamma correlations that represent the likelihood they would select a face they rated as more familiar during the exploration phase. Finally, there was no main effect of version when comparing the d' scores (1a: $M = 1.86$, $SD = 0.865$; 1b: $M = 1.80$, $SD = 0.839$), $F(1, 114) = 0.167$, $p = .683$. The participants in version 1a were able to identify previously studied faces as more familiar to the same extent as participants in 1b. Considering there was no difference between the two versions in the main memory judgments, the remaining results will use the complete dataset from Experiment 1 to compare the age effects on memory judgments following unsuccessful recall.

After completing Experiment 1a and realizing the expected recall deficit was not observed among the older adults, I introduced multiple-choice questions about the instructions to the experimental paradigm to measure engagement and understanding of the task. I predicted that increasing the engagement of the task and understanding of the instructions, I would see improved recall among the younger individuals or if individuals scored lower than 6/8 on the multiple-choice questions, I would exclude them for not understanding the instructions.

The single difference between the paradigm used in Experiment 1a and Experiment 1b was the addition of multiple-choice questions that were designed to serve as engagement checks. The two items related to the multiple-choice questions were how long it took participants to respond and how well participants performed on the multiple-choice questions. As mentioned previously, the engagement checks were to be used as exclusion criteria – if participants took longer than 10 s to respond or scored 5/8 or lower, they were excluded. No one was excluded from the analyses for these reasons. The other point of interest for the engagement checks was to see if the accuracy on the multiple-choice questions correlated to the performance on the initial recall task. A quick comparison for the recall accuracy of those who scored 6/8 to those who scored 8/8 shows that the recall accuracy for those who scored 6/8 ($M = 14.6\%$, $SD = 13.4\%$) was not significantly different than those who scored 8/8 ($M = 10.8\%$, $SD = 7.51\%$), $t(29) = 1.02$, $p = .318$.

Appendix C: Ethics Approval Letter

Date: 14 September 2022

To: Prof. Stefan Kohler

Project ID: 113081

Study Title: Exploring the motivational significance of memory experience

Application Type: NMREB Amendment Form

Review Type: Delegated

Full Board Reporting Date: 07/Oct/2022

Date Approval Issued: 14/Sep/2022 16:17

REB Approval Expiry Date: 28/Jan/2023

Dear Prof. Stefan Kohler,

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the WREM application form for the amendment, as of the date noted above.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
RepresentativeFaceStimuli1	Other Data Collection Instruments		
RepresentativeFaceStimuli2	Other Data Collection Instruments		
RepresentativeFaceStimuli3	Other Data Collection Instruments		
113081_20220518_ProlificRecruitmentAging	Recruitment Materials	18/May/2022	1
113081_20220819_LOI_Aging_OLD (1)	Implied Consent/Assent		
113081_20220819_onlinesurvey_Young	Online Survey		
113081_20220819_OnlineSurvey_Old	Online Survey		
113081_20220913_LOI_Aging_YOUNG (1) (1) (1)	Implied Consent/Assent		

Documents Acknowledged:

Document Name	Document Type	Document Date	Document Version
113081_20220428_Debriefing_Aging	Other Materials		

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario. Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Ms. Katelyn Harris, Ms. Zoë Levi, Research Ethics Officer on behalf of Dr. Randal Graham, NMREB Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Curriculum Vitae

Rachel Sargeson

Education

M.Sc., Neuroscience – Western University

2021 – Present

Thesis: Can we leverage curiosity to overcome age-related memory decline?
Coursework includes Neuroimaging of Cognition, Scientific Computing, and Principles of Neuroscience

Honours B.Sc., Psychology & Neuroscience – Wilfrid Laurier University

2017 – 2021

Minors: Biology and Chemistry.
Thesis: Effects of emotion on facial recognition after a time delay using a two-alternative forced-choice recognition test
Coursework included Research in Behavioural Neuroscience, Cognitive Neuroscience, Linear Models, and Cell Biology

Research Experience

Graduate Research – Western University

2021 – Present

Dr. Stefan Köhler
Investigating how preserved feelings of familiarity can be used to induce curiosity and improve recall deficits in healthy aging individuals.

Undergraduate Honours Thesis – Wilfrid Laurier University

2020 – 2021

Dr. William Hockley
Examined the effects of emotion on facial recognition after a time delay using a two-alternative forced-choice recognition test.

Research Assistant – Wilfrid Laurier University

2020

Dr. Laurie Manwell
Performed c-Fos cell quantification on the brain tissue of rats following an overstimulation study. The c-Fos cell quantification was completed following an immunohistochemistry procedure.

Conference Presentations

Rachel Sargeson, Gregory Brooks, Jasper Crockford, Stefan Köhler. "Aging Effects on Familiarity and Curiosity". Poster Presentation. Lake Ontario Visionary Establishment Conference, Niagara Falls, Canada. February 9-10, 2023.
Rachel Sargeson, Gregory Brooks, Jasper Crockford, Stefan Köhler. "Aging Effects on Familiarity and Curiosity". Data Blitz Talk. Toronto Area Memory Group, Toronto, CA. May 16, 2023.

Teaching

Graduate Teaching Assistant – Western University

- Marked assignments, presentations, short-answer exam questions and research papers, lead 1 – 4 tutorials/labs a week, held office hours and had meetings with students.
- Psychology 1000A: Introduction to Psychology as a Natural Science (September – December 2021); Psychology 1000B: Introduction to Psychology as a Natural Science (January – April 2022); Psychology 2811A: Statistics for Psychology I (September – December 2022); Psychology 2802: Research Methods in Psychology II (January – April 2023)

Mentoring and Supervising

Honours Thesis Students – Western University

Sihan Cai (September 2022 – April 2023)
Jasper Crockford (September 2022 – April 2023)

Scholar's Elective Students – Western University

Aditya Thakur (September 2022 – Present)

Summer Research Interns – Western University

Sabrina Saladeen (May 2023 – Present)
Jessica Zhang (May 2023 – Present)

Volunteer and Outreach

Student Representative

2021 – 2022

BrainsCAN Trainee and Research Staff Committee

- Assisted with running a well-attended interactive research day that focused on science communication for trainees and students within the neuroscience research department
- Reviewed applications for BrainsCAN's 2022 Diversity in Neuroscience Internship

General Member

2017 – 2018

WE Laurier

- Ran a fundraiser to raise money for Education initiative
- Attended regularly scheduled meetings plan and organize events