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Aging, Motivation, and Memory for Important Information

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by

Mary Bryce Hargis

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ABSTRACT OF THE DISSERTATION

Aging, Motivation, and Memory for Important Information

by

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Doctor of Philosophy in Psychology

University of California, Los Angeles, 2019

Professor Alan Dan Castel, Chair

Across the adult lifespan, we pursue many different goals: we may learn new information, try to stay healthy, and build relationships with loved ones. Previous work (e.g., socioemotional selectivity theory, Carstensen, Isaacowitz, & Charles, 1999) suggests that while younger adults pursue primarily knowledge-based goals, older adults pursue primarily social and emotional goals. Though this shift in priorities is supported by substantial evidence, what motivates us to learn in healthy aging may be more complex than a single theory may suggest. The current Dissertation investigates how learners remember information with primarily social goals (Chapter 2) and primarily knowledge-based goals (Chapters 3 and 4), as well as how variables such as age and information importance can affect memory and metacognition.

Though age-related deficits for associative information are well-established (e.g., Naveh-Benjamin, 2000), older adults are often able to prioritize and associate items in memory that are

the most important to remember, given their learning goals. Metacognition is a critical component of how we monitor and control our learning, and some evidence in this Dissertation suggests that we do not have accurate representations of our memory abilities. However, overconfidence is not ubiquitous: for example, we are aware that we may not be very good at remembering other peoples' names; also, after a difficult associative memory task, we may remedy our overconfidence about our own memory abilities and others'.

An overarching theme among these studies is the investigation of how people learn what it is they need to know in order to achieve their goals. The current research suggests that, especially when given the opportunity to learn from their mistakes, learners young and old can successfully pursue a diverse array of learning goals. While substantial previous work focuses on a shift from knowledge-based to socioemotional goals in older adulthood, the current studies support the notion that a more general value-based mechanism guides learning behavior. These previous socio-emotional models are a helpful framework, but the evidence suggests that value and importance drive learning and goal pursuit in aging. Determining what information is important to remember, what information can be forgotten, and what information will be useful in achieving a goal are complex cognitive processes in which many older adults may still be quite successful, even in light of deficits in memory.

The dissertation of Mary Bryce Hargis is approved.

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2019

DEDICATION

To my grandfather, Henry Bryce Tindall:

Thank you for sharing your knowledge and your name with me –

and for starting my fascination with memory on the screened porch at Edisto.

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CHAPTERS IN EDITED BOOKS

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SELECTED PRESENTATIONS

1. **Hargis, M. B.** (2018). *Motivated Memory, Learning, and Cognitive Aging.* Invited talk at the University of Illinois at Chicago, Chicago, IL.

2. **Hargis, M. B.** (2018). *Motivated Memory, Decision-Making, and Cognitive Aging.* Invited talk at Texas Christian University, Fort Worth, TX.

3. **Hargis, M. B.**, Castel, A. D., & Bjork, R. A. (2018). *Does the Decision to Offload Information Influence Forgetting?* Presented at the Psychonomic Society Annual Meeting in New Orleans, LA.

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5. **Hargis, M. B.,** & Castel, A. D. (2017). *Younger and Older Adults' Memory and Metacognition for Medication Side Effects.* Presented at the Psychonomic Society Annual Meeting in Vancouver, Canada.

6. **Hargis, M. B.,** Castel, A. D., & Bell, D. S. (2016). *Memory and Metacognition for Medication Interactions.* Presented at the Psychonomic Society Annual Meeting in Boston, MA.

7. **Hargis, M. B.,** & Castel, A. D. (2016). *Memory for Important Faces: The Role of Aging and Social Goals.* Presented at the 16th Biennial Cognitive Aging Conference, Atlanta, GA.

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CHAPTER 1: INTRODUCTION

Across the adult lifespan, our goals often include gaining new knowledge, building relationships, and staying healthy. While younger adults may seek to gain knowledge in school and at work to excel in their chosen careers, many older adults have different priorities, such as improving their social and emotional well-being. Older adults may pursue relationship-building activities with close friends and family, while younger adults choose to focus on learning new information. However, cognitive aging is a multifaceted process, and goal pursuit is likely more complex than a single theory may suggest. For example, many older adults also pursue learning for the sake of acquiring knowledge, and many spend time on hobbies such as birdwatching or travelling that involve learning new information and exploring new situations.

Motivational differences throughout adulthood are thought to be related to individuals' perceptions of their futures: if individuals are aware that their time on earth is limited, that time is spent differently than if the future seems expansive. When younger and older adults are given the hypothetical option to spend time with another person, younger adults gravitate towards spending time with those they do not know well, while older adults choose to spend time with those with whom they are already in close relationships. This is not to say that younger adults do not care about building social relationships; in fact, younger adults' choices show a reversed pattern (such that they choose to spend time with closer friends and family more than those with whom they are not as close) when the fragility of life is primed by events such as the SARS epidemic and the September 11th terrorist attacks (Fung & Carstensen, 2006), or by a more predictable ending such as graduating from college (Ersner-Hershfield, Mikels, Sullivan, & Carstensen, 2008).

In fact, this well-established pattern of socio-emotional goal pursuit may not always hold for older adults, either. It is apparent that older adults seek out relationship-building and emotion-regulation goals, and this has been extensively examined in the literature. However, older adults also seek to learn new things: prior work suggests that many older adults who are engaged in formal learning programs joined these programs to gain knowledge for the sake of learning (Wolfgang & Dowling, 1981), and very few report that they joined such a program for social or emotional reasons. Even those not engaged in formal learning programs seek out information in service of their hobbies, interests, or health. These activities may be intertwined with socio-emotional goals, such as the older adult who tries to remember important information about a medical diagnosis to discuss later with her spouse or friends, but the motivation to acquire knowledge is still present, as is the need to prioritize information that is important to achieve one's goal.

Older adults often have goals in common with younger adults, but the pursuit of these goals may be different, at least partially due to the resources available to pursue such goals. For instance, in the context of memory and learning, younger and older adults likely differ on both their performance abilities and their functional goals. Some deficits in cognitive processing accompany healthy aging, and these deficits may limit the extent to which older adults can pursue goals that are categorized (often by researchers) as knowledge-based, such as spending time with a new and informative social partner or attending university lectures. However, older adults can be as accurate as younger adults at remembering information that is deemed to be important or valuable, either by the individuals themselves or by the experimenter. The value of to-be-remembered information can significantly affect one's likelihood of recalling it later, and the difference in memory for unimportant and important information is often even more pronounced for older adults than it is for younger adults. As we face environments in which we cannot hope to remember everything (during a course lecture, for example, or at the doctor's office), we may select a relevant group of items based on our goals in that situation and exert strategies to remember those items to the best of our ability.

When a set of items or facts is important to remember, but we recognize the potential to forget some or all of information, we may choose to offload the information (e.g., by writing it down or saving it to an external device). Different types of information may be associated with different levels of likelihood of forgetting: some information considered easy to remember or important may have a lower likelihood of being forgotten (and is thus not necessary to offload), while other information that is complex or unimportant has a higher likelihood of being forgotten (and thus would benefit from offloading). Variables that influence memory and metacognition such as value and likelihood of forgetting are important to assess when investigating potential age differences in motivation to learn, as the ability of individuals across the adult lifespan to recall information and to make judgments about their cognition often depends upon the goals the participant is pursuing.

This Dissertation begins by exploring how age may affect learning information *about* other people (Chapter 2, Experiments 1 and 2, Study 3). Then, I will examine how younger and older adults learn information to communicate *with* other people (Chapter 2, Experiments 4 and 5), as well as how learning across a task can be affected by knowledge-based goals that do not have a primary social component (Chapters 3 and 4). An overarching theme among these chapters is the examination of how people learn what it is they need to learn, often using multiple study-test trials to examine learning across a task. Another theme uniting these studies is that many require associative memory (i.e., binding multiple, often unrelated, items in memory), the accuracy of which has been shown to decline in healthy aging. Even though older adults may struggle with this type of learning, associating items in memory is an important skill that people across the lifespan use in daily life, such as when we meet someone new and seek to match their name to their face. Overall, this Dissertation supports the notion that determining what information is important to remember, what information can be forgotten, and what information will be useful in achieving a goal are complex cognitive processes in which many older adults may still be quite successful, even in light of deficits in memory.

Memory for valuable information

The cognitive declines that accompany healthy aging are well-documented. Associating items in memory (Naveh-Benjamin, 2000), recalling particular events from one's past (Levine et al., 2002; Mitchell, Brown, & Murphy, 1990), and manipulating items in memory (Salthouse, Mitchell, Skovronek, & Babcock, 1989) may all be difficult for an older adult. Healthy older adults often complain of memory errors such as where they placed their car keys, the name of the person they met earlier, or whether they are supposed to take their new medication with food. Younger adults may experience very similar errors but often chalk them up to being busy, tired, or rushed, while an older adult may assume (sometimes correctly) that these errors are part of getting older, or that they indicate concerning changes in cognitive health.

Anderson and Schooler (2000) constructed a framework that explains how information that is needed in the future is stored and recalled. This construct, termed "need probability," relates the likelihood of future use of a set of information to the likelihood that the information is recalled. If this information is high in need probability, it is considered more likely to be remembered, regardless of one's age. Nevertheless, age is an important factor in determining what gets remembered and what strategies are used to do so. In the domain of cognitive aging, we may consider important information to be related to one's health, one's interests, and more, including whatever the experimenter suggests will likely be on the upcoming memory test.

If a reward is associated with the recall of a particular item — such as points being added to a participant's score on that task — that item is likely to be associated with a higher need probability, and thus become more important to remember. If there is more information presented than one can hope to remember, one can use strategies that vary in effectiveness to remember the valuable information. Should I try to amass as much information as possible with the limited study time I have, through brute-force memorization? Should I pay attention to the items that are easiest for me to learn, then move on to harder items? Should I use my study time on the items that are worth the most points, and direct attention away from less-valuable items? When the experimenter randomly assigns points to words as the indicator of their value, participants seem to engage in the last strategy: recalling the words that increase their score the most (e.g., by focusing on a 12-point word over a 2-point word). Of the words recalled in tasks like these, many are high-value, indicating a focus on those items at some point during study, which many participants report doing after the task is completed.

Not all value paradigms are constructed with randomly-paired point values, however, as value-directed remembering tasks can be adapted to allow for the use of more naturalistic stimuli that may reflect how participants learn valuable information outside of the lab. Middlebrooks, McGillivray, Murayama, and Castel (2015) utilized a list of allergens, Friedman, McGillivray, Murayama, and Castel (2015) presented participants with medication side effects, and Castel et al. (2016) asked participants to remember information about people who owed them various amounts of money (see Chapters 2 and 3 of this Dissertation for more examples). Younger and older people are able to execute effective strategies to remember the most important information in such tasks. These findings are particularly interesting in the domain of healthy cognitive aging, as memory for associative information can often be affected by the age-related memory deficits discussed above (Naveh-Benjamin, 2000). Age differences are also present in many studies, however, when considering overall memory performance: younger adults tend to correctly recall more information overall than older adults do. This Dissertation examines how and why people remember important information using point value structures, as well as stimuli that people are more likely to encounter outside the lab, such as social and medical information.

Metacognition across the lifespan

When we study, we often make assessments about how well we have learned something, perhaps adjusting our strategies to remember more (or different) information on the next memory test. Metamemory includes the selection and use of strategies, perceptions about how memory works, and memory self-efficacy (Hertzog, Dixon, & Hultsch, 1990). Hertzog & Hultsch (2000) suggest that there are three main components of metacognition: knowledge about cognition and cognitive functions, monitoring of the current state of the cognitive system, and beliefs about cognition (including one's own cognition and others'; see Chapter 2, Experiments 3 and 4). These judgments can be collected in a variety of contexts, including asking participants for pre-task predictions of performance, judgments of learning made during the study phase, or post-task confidence ratings of test performance (or some combination of the three). Some of the studies described below directly ask for participants' pre-task and post-task metacognitive judgments (e.g., Chapter 3, Experiments 3 and 4), but several of the other studies assess metacognition from a more indirect perspective. For example, the use of a value-based strategy in Chapter 4 may reflect a sophisticated understanding of one's ability to perform in a memory task, and/or the optimal way(s) to pursue one's goal.

Overall, the literature on age-related differences in metacognition is mixed. Deficits can occur under certain circumstances in which older adults are disadvantaged, but other tasks that tap into preserved abilities suggest that these age-related declines are not universal. Prior work illustrates equivalences between younger and older adults in their post-task judgments about their memory performance on a recently completed test (Perlmutter, 1978), their ratings of likelihood of recalling each item in a study phase (Lovelace & Marsh, 1985), and their comprehension of texts, which also requires metacognition (Zabrucky, Moore, & Schultz, 1987).

There are reasons to believe, however, that metacognition may be detrimentally affected by the process of healthy aging. Older adults are often overconfident in their memory performance (Brigham & Pressley, 1988). A particular area of interest, and one in which older adults tend to be less accurate, is the use of metacognitive strategies: Older adults do not endorse certain effective strategies as in fact being effective, while younger adults do notice these differences (Brigham & Pressley, 1988). However, the value-directed remembering literature (e.g., Castel, 2008) suggests that older adults (and younger adults) may learn effective memory prioritization strategies with task experience. On a task in which the goal is to remember high-value items to maximize one's score, older adults are often able to execute such strategies if given multiple study-test opportunities. While older adults are less accurate in recalling the lowest-value items, they often perform as well as younger adults in recalling the highest-value items. Though any number of memory strategies could be used during study (e.g., making a story out of the list of to-be-learned words, fitting them into a mental image of a scene, or using no strategy at all), there is evidence for the use of an overall value-based strategy in the memory performance of both younger and older participants.

Pursuit of socioemotional and knowledge-based goals

A critical component of the aging process is the conception of time, specifically the time remaining in one's life. As we age, the limited nature of our time left on earth becomes more salient (Carstensen, Isaacowitz, & Charles, 1999). Awareness of a limited amount of time remaining may lead older people to pursue certain goals that are different in many ways than how younger adults pursue their goals. For example, the experience of social contact becomes more about *quality* than about *quantity*: that is, an older adult may seek to spend time with a few close friends or family members rather than meet and get to know a large group of acquaintances, and this pattern can be reversed for a younger adult whose social preferences often include those which fulfill knowledge-acquisition goals.

Carstensen and colleagues (1999) argue that the perception of endings leads individuals across the lifespan to experience an emphasis on feelings, and this leads to the pursuit of goals in line with that emotional emphasis. Substantial work supports this argument (Charles & Carstensen, 2010; Carstensen & Charles, 1998; Carstensen, Fung, & Charles, 2003; Ersner-Hershfield et al., 2008; Fredrickson & Carstensen, 1990; Fung, Carstensen, & Lutz, 1999). Further, Carstensen et al. (1999) propose that emotional goals are fundamentally different from knowledge-based goals. Emotional goals may include avoiding negative states, pursuing positive states, and getting to know someone. Knowledge acquisition goals can include some social component (e.g., planning to share a new medical treatment plan with a loved one), but the primary aim of these goals is to learn about the world. The differences between knowledge acquisition and emotional goal-seeking are fairly nuanced; to include the conception of time as a major factor can help distinguish the two. For example, learning how to get along with one's colleagues in one's early twenties can be considered a future-oriented goal as one seeks to build knowledge and skills in interacting with people of different backgrounds and cultures that will surely be helpful in one's future workplace interactions.

When time horizons are broad and expansive, future-oriented goals are the priority. When time horizons are limited, the future is necessarily less expansive, so knowledge-based goals are no longer prioritized. Emotional and knowledge acquisition goals often compete with each other, but this competition becomes less salient as we notice that time is, in a sense, "running out." Carstensen et al. (1997) acknowledge that there are obviously emotional components to some knowledge-acquisition tasks and vice versa, but they do argue that older adults primarily focus on satisfying their emotional needs while knowledge-based goals become less important (see Figure 1.1 for a schematic diagram of goal pursuit across the lifespan according to socio-emotional selectivity theory).

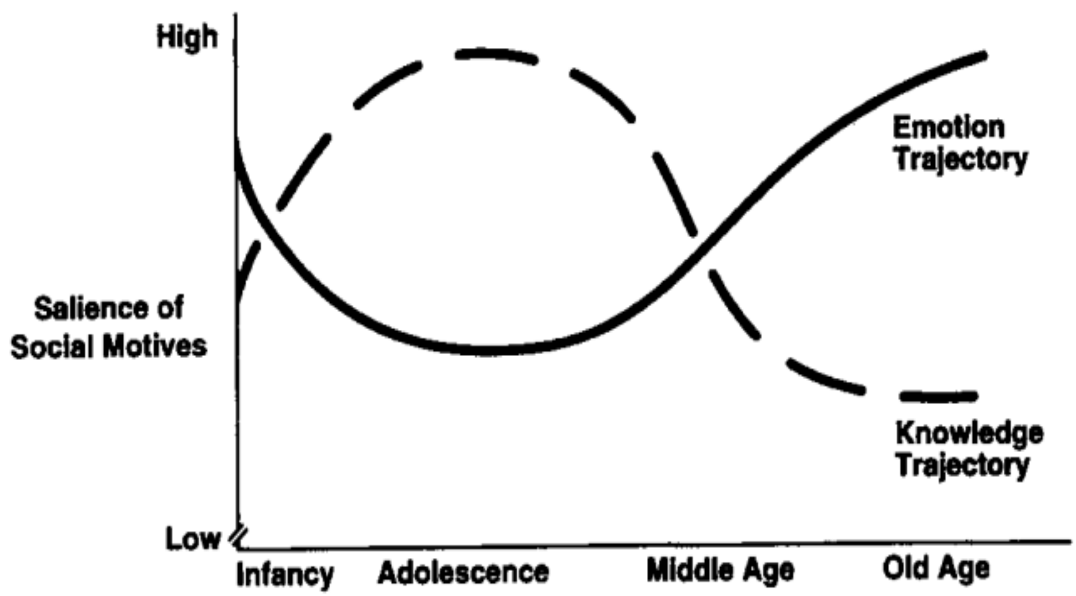

Figure 1.1. A schematic diagram of how goals change throughout the lifespan. Carstensen, Gross, and Fung (1997) suggest that knowledge-based goals become relatively unimportant in older adulthood after peaking in adolescence, and that emotion-based goals have the opposite trajectory.

Deciding which goals to pursue is not entirely dependent upon chronological age, however. It may not tell the whole story to simply state that older adults care about social goals and emotion regulation and that younger adults care about gaining knowledge. There are many circumstances under which the roles are reversed, and these do not appear to be merely superficial exceptions to the general rule. Situations in which older adults seek knowledge are important and worth recognizing from a theoretical perspective, even though much of the prior work on this topic does reflect older adults' preference for socioemotional goals.

For example, a particular type of knowledge-based goal that younger and older adults may often pursue is learning information they are curious about. McGillivray and colleagues (2015) investigated how interest affects memory by presenting younger and older adults with different trivia items and asking them which of the questions they felt confident in answering correctly. When asked to recall the answers to the questions later, there were no age-related differences in recall accuracy, which is surprising given the associative nature of the task. Memory performance for both age groups after a one-week delay was significantly less accurate than performance on the immediate test, as expected. Interestingly, older adults' recall accuracy was strongly predicted by the ratings they gave after learning the answers to the trivia questions, while younger adults' recall was less strongly predicted by this factor. This finding underscores the importance of interest in older adults' long-term learning of information, and why it should be considered a strongly motivating factor when older adults seek new information. In this Dissertation, I examine younger and older adults' memory and metamemory for valuable, perhaps interesting information that would serve them in pursuing social and/or knowledge-based goals (see Hargis et al., 2017 for a deeper examination of interest, memory, and aging).

There are notable situations in which older adults seek to learn, and examining those cases can help us better understand how motivation and goal pursuit change across the adult lifespan — or, perhaps, do not change as much as prevailing theories suggest. In Chapter 2 of this Dissertation, different facets of the impact that socio-emotional goals can have on memory and learning will be examined in the context of learning information about other people (e.g., their names and occupations). Experiments 4 and 5 in the same Chapter examine situations in which we also seek to learn for socio-emotional reasons, but rather than information *about* others, these experiments will examine how people learn information they would use *with* others. Chapter 3 explores how younger and older adults learn health-related information when faced with knowledge-based goals (e.g., learning about medication interactions or side effects). Chapter 4 examines how value can affect learners' decisions to commit information to memory or save it to an external source, and how these decisions may or may not change with task experience. The aim of this Dissertation is to assess how healthy aging and information importance may affect memory and motivation to learn, with potential applications to social (Chapter 2), health (Chapter 3), and educational (Chapter 4) domains.

CHAPTER 2: YOUNGER AND OLDER ADULTS' MEMORY FOR IMPORTANT SOCIAL INFORMATION

Portions of the following introductory comments, Experiments 1 and 2, and portions of the conclusion are taken directly from Hargis & Castel (2017)

There is often a shift in what goals we choose to pursue across the adult lifespan. Younger adults tend to pursue goals that will build their knowledge — many of their waking hours are spent learning information that may (or may not) be useful in their later careers. Younger adults' tendency to pursue knowledge has even been found in their choice of social partners; when given the choice, they often choose to interact with acquaintances or authors of books they have recently read, rather than a close friend of family member (Fredrickson & Carstensen, 1990; cf. Fung & Carstensen, 2006). Older adults, however, prefer to interact with people with whom they have already established relationships. Goals in daily life can also motivate behavior in a lab-based memory task; indeed, some tasks in this Chapter (and, for the most part, in this Dissertation) are built to be similar to real-life situations in which we may need to learn about others (e.g., meeting people at a party) while also maintaining as much internal validity as possible given individual differences in abilities and opinions about what is truly important. The current work examines potential age-related differences in motivation within the domain of learning and memory.

Chapter 2 explores how younger and older people are motivated to remember information that contains different social components: information about potential social partners themselves (Experiments 1 and 2; Study 3), or information that one may wish to use when communicating with a social partner (Experiments 4 and 5). Chapter 2 serves to support the argument that younger and older adults can be strongly motivated by building relationships, and future Chapters will expand upon motivation to include knowledge-based goals.

Experiment 1

During everyday social interactions, we often attempt to remember information about people we meet. As we age, we may face situations in which we cannot remember all of the social information in our environment. Older adults often complain about forgetting names (Troyer, Häfliger, Cadieux, & Craik, 2006), and there is evidence that the impairment in face-name binding is a specific subset of an overall age-related associative deficit among older adults (Naveh-Benjamin, Guez, Kilb, & Reedy, 2004; cf. McGillivray & Castel, 2010). On the other hand, occupation information may be processed more deeply than names are, leading to better memory for individuals' occupations (Cohen, 1990; Fogler, James, & Crandall, 2010). Older adults' prior successful task performance can promote future accuracy (Geraci & Miller, 2013), and older participants tend to become more selective – that is, recalling more high-value items than low– with task experience (Castel, 2008). Festini, Hartley, Tauber and Rhodes (2013) found that younger adults are sensitive to value when learning face-name pairs, but this has yet to be examined in older adults, and with value categories that are more socially relevant. Despite widely-documented associative memory deficits (Old & Naveh-Benjamin, 2008), older adults may be able to focus on remembering associated information about people they will encounter in the future, and for a subset of important individuals that may be most relevant to remember.

In the current study, we use a novel value structure: social information that varies with respect to the likelihood of the participants' future use of it (Anderson & Schooler, 2000). Basing value on the likelihood of future use and utilizing several study-test phases may reduce older adults' associative memory deficits. While younger adults may recruit effective encoding strategies to remember a large quantity of information, older adults' awareness of memory capacity limitations may lead to lower memory accuracy for low-value items but relatively high recall of important information (Castel, 2008). Older age may lead to seeking emotionally meaningful interactions, while goals that focus on acquiring information are perceived as less important (Lang & Carstensen, 2002). If older adults' goals support remembering a person with whom they will interact in future (e.g., their new doctor), they may be able to selectively remember item and associative information about these important people.

In Experiment 1, we examined the impact of importance on younger and older adults' memory for associative social information. Specifically, we were interested in whether recall would be affected by the likelihood of hypothetically meeting the studied people in the future and whether this would differ between age groups. Participants saw 20 face-name-occupation items and were tested via free recall tests (with restudy periods) and a final cued-recall test.

Method

Participants

Twenty-four younger adults (20 females) aged 18 –21 years (*M* = 19.78, *SD* = 1.92) participated in this experiment. They had an average educational level of 13.91 years (*SD* = 1.76), were undergraduates at the University of California, Los Angeles (UCLA), and were given course credit for their participation. Twenty older adults (10 females) aged 61– 82 years (*M* = 69.55, *SD* = 5.60) had an average educational level of 16.09 years (*SD* = 1.48), were from Los Angeles, were in good health, *M* = 8.40 (*SD* = 1.33) on a scale from 1 (poor health) to 10 (excellent health), and received $10 per hour for their participation.

Materials and Procedure

Participants were told to imagine that they were attending a party where they would meet 20 new people and that they had 3 s to view and study each person's face, name, and occupation. Participants were told that personally important people included those with whom there would be a definite future interaction (information about whom would appear in orange text), while broadly important people were those who would be seen again but with whom the participant would not interact (blue text); less important people would not be seen or interacted with again (black text). Participants were to remember as much information as possible, "keeping in mind the likelihood of interacting with that person again."

All photographs in this experiment were of middle-aged adults of various ethnic groups (10 with neutral expressions, 10 smiling, all photographs in color, half male and half female; Minear & Park, 2004), each of which was presented on a computer screen under the individual's name and occupation. The assignment of names to photographs was randomized within each gender, and the assignment of people to each occupation was also randomized. The high-value and medium-value occupations were always presented with photographs of smiling faces, and the low-value occupations were randomly associated with the remaining photographs of smiling or neutral faces. This particular value structure was constructed with the notion in mind that it is unlikely that a high percentage of people one meets at a party would be highly important to remember. Prior value-directed remembering tasks (e.g., Castel, Farb, & Craik, 2007) categorize three to four items as "high value" and separate the remaining items into lower value categories. Other experiments examining memory for faces have used, for example, six faces per category (Mealey, Daood, & Krage, 1996) and two faces per category (Castel et al., 2016). Therefore, 3 items were assigned to the "personally important" category, 3 items to the "broadly important" category, and 14 items to the "less important" category. Common occupations (e.g., sales clerk) were randomly assigned to the people with whom the participants would not interact or see again, while the "broadly important" and "personally important" categories included "future television star" and "your new doctor," respectively. Each face-name-occupation triplet was studied in randomized order for 3 s. Participants then completed an untimed free recall test in which they were to enter information about the people they had just "met" in columns labeled "Name" and "Job" on the computer screen. Each participant completed four study-test phases, with the same information on each list in newly randomized orders. Participants then completed an untimed cued recall test, in which they saw each photograph and were asked to enter the person's name and occupation. Participants then gave their opinions on a 5-point Likert scale (from 1 indicating *not important* to 5 indicating *very important*) of how important it would be to remember a person with each occupation used in the study. This research was approved by the UCLA Institutional Review Board ethics committee.

Results

Free recall tests

The results from the free recall tests are presented in Figure 2.1. The accuracy of information presented in the less important category was analyzed separately from information presented in the other categories, due to differences in the amount of information in the categories. To investigate possible age or value differences in free recall of personally and broadly important information, a 2(Importance: broad or personal) × 2(Participant age: younger or older) × 4(Test phase) analysis of variance (ANOVA) was conducted, revealing no significant main effect of age, $F(1, 42) = 2.26$, $p = .14$, $\eta^2_p = .05$. There was a significant main effect of information importance, $F(1,42) = 7.89$, $p < .01$, $\eta^2_p = .16$, such that information about personally important people ($M = 1.67$, $SD = 1.18$) was remembered significantly more accurately than information about broadly important people (*M* = 1.39, *SD* = 1.95). There was a significant main effect of test, $F(3, 126) = 51.95$, $p < .001$, $\eta^2_p = .55$, such that performance on Test 2 (*M* = 1.45, *SD* = 0.82) was more accurate than on Test 1 (*M* = 0.51, *SD* = 0.81), $t(43) = 5.37$, $p < .001$. Performance on Test 3 (*M* = 1.94, *SD* = 1.12) was more accurate than on Test 2, $t(43) = 3.34$, $p < .01$, and performance on Test 4 (*M* = 2.22, *SD* = 1.00) was not significantly different from Test 3 $t(43) = 1.89$, $p = .37$. No other effects were significant, *p*s > .29.

To analyze the recall of less important information, a 2(Participant age: younger or older) × 4(Test phase) ANOVA was conducted and revealed a significant two-way interaction between test and age, $F(3, 126) = 10.88$, $p < .001$, $\eta^2_p = .21$. Post hoc t-tests with Bonferroni corrections indicated that younger adults performed more accurately on Test 2 than on Test 1 (*M* = 3.79, *SD* = 2.98 and *M* = 1.21, *SD* = 1.79, respectively), $t(23) = 4.08$, $p < .001$, more accurately on Test 3 (*M* = 6.63, *SD* = 3.94) than on Test 2, $t(23) = 4.18$, $p < .001$, and as accurately on Test 4 (*M* = 7.58, *SD* = 4.98) as on Test 3, $t(23) = 1.46$, $p = .16$. Older adults' performance on Test 2 was more accurate than on Test 1 (*M* = 1.21, *SD* = 1.79 and *M* = 0.80, *SD* = 1.15, respectively), $t(19) = 2.24$, $p = .04$, and performance on Test 3 (*M* = 1.80, *SD* = 1.85) was more accurate than on Test 2, $t(19) = 2.43$, $p = .03$. There was no difference in older adults' performance on Tests 3 and 4 (*M* = 1.80, *SD* = 1.85 and *M* = 1.80, *SD* = 2.02, respectively), $t(19) < 1$, $p = 1.00$. There was a significant main effect of age, $F(1, 42) = 30.35$, $p < .001$, $\eta^2_p = .42$, such that younger adults remembered more information associated with people of less importance than older adults did (*M* = 4.36, *SD* = 4.36 and *M* = 1.18, *SD* = 1.62, respectively).

Cued recall test

Recall of names and occupations were scored separately on the cued recall test. A 2(Importance: broad or personal) × 2(Participant age: younger or older) × 2(Characteristic:

name or occupation) ANOVA revealed a main effect of characteristic on cued recall performance, $F(1, 42) = 11.64$, $p < .001$, $\eta^2_p = .22$, such that occupations were recalled more accurately than names ($M = 2.38$, $SD = 0.88$ and $M = 2.16$, $SD = 0.96$, respectively, see Figure 2.1). There was no effect of age, $F(1,42) = 2.67$, $p = .11$, $\eta^2_p = .06$. There was a significant two-way interaction between characteristic and age, $F(1, 42) = 4.71$, $p = .04$, $\eta^2_p = .10$. Post hoc t-tests with Bonferroni corrections revealed that there were no significant differences in younger adults' recall of names and occupations, $t(23) = 1.07$, $p = .30$. However, older adults recalled occupations significantly more accurately than they recalled names ($M = 2.25$, $SD = 0.75$ and $M = 1.88$, $SD = 0.90$, respectively), $t(19) = 3.29$, $p < .01$. No other effects were significant, $ps > .12$.

A 2(Participant age: younger or older) × 2(Characteristic: name or occupation) ANOVA was used to analyze cued recall accuracy of less important information, and revealed a two-way interaction, $F(1, 42) = 16.66$, $p = .001$, $\eta^2_p = .28$. Post-hoc t-tests revealed no significant differences in younger adults' recall of names and occupations, $t(23) = 0.53$, $p = .60$, while older adults recalled occupations significantly more accurately than they recalled names ($M = 6.05$, $SD = 3.93$ and $M = 3.30$, $SD = 2.88$, respectively), $t(19) = 5.60$, $p < .001$. There was a significant main effect of age, $F(1, 42) = 19.54$, $p < .001$, such that younger adults outperformed older adults ($M = 9.85$, $SD = 3.76$ and $M = 4.48$, $SD = 3.87$, respectively).

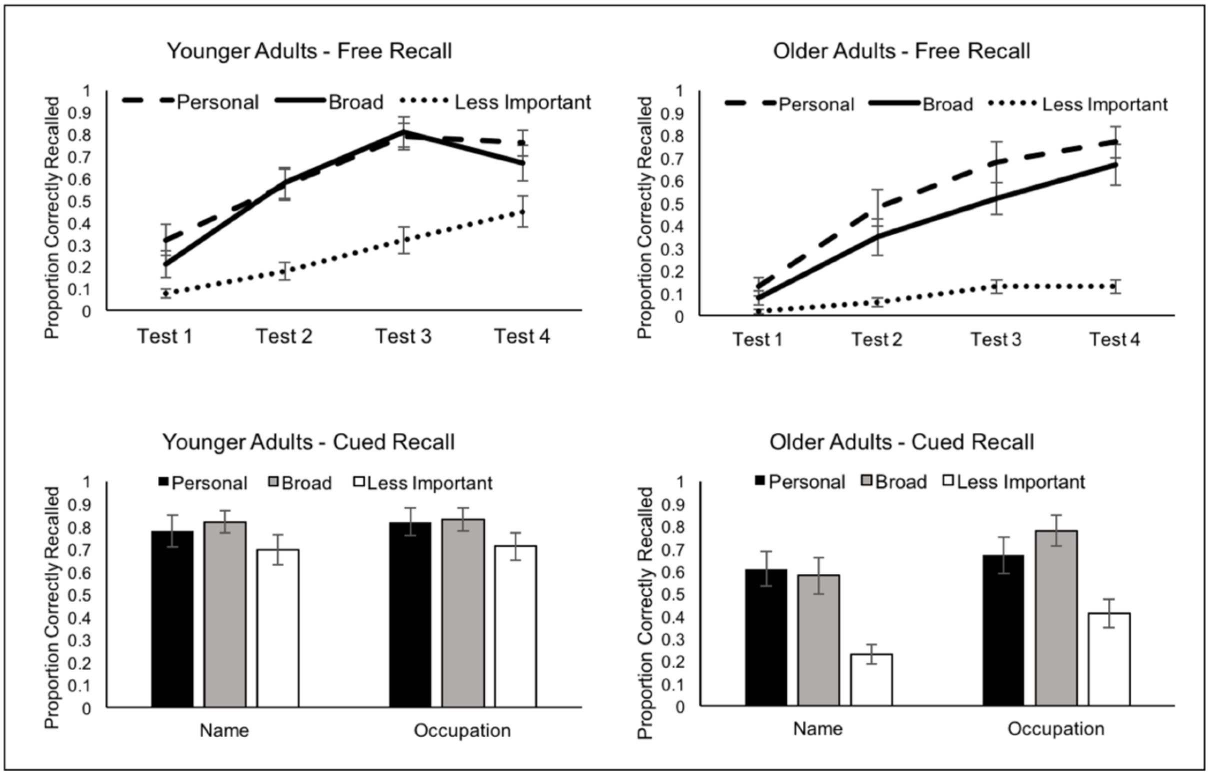

Figure 2.1. The proportion of personally important, broadly important, and less important information correctly recalled by younger adults and older adults in the four free recall tests (top panel) and final cued recall test (bottom panel) in Experiment 1. Error bars indicate standard error of the mean.

Importance ratings

After the cued recall test, participants gave their own opinions (on scales from 1 = *not important* to 5 = *very important)* for the importance of remembering a person with each occupation. A 2(Age: younger or older) x 3(Importance: personal, broad, or less important) analysis of variance (ANOVA) on participants' importance ratings revealed a significant main effect of importance $F(2, 84) = 49.68$, $p < .001$, $\eta^2_p = .54$, such that information in the "personally important" category was rated as subjectively more important than information in the "broadly important" category ($M = 4.20$, $SD = 0.78$, and $M = 3.44$, $SD = 1.02$, respectively, $t(43) = 5.11$, $p < .001$), and that information in the personally important category was rated as more important than information in the "less important" category ($M = 2.66$, $SD = 0.61$, $t(43) = 9.97$, $p < .001$), and information in the broadly important category was rated as more important than information in the less important category, $t(43) = 4.86$, $p < .001$. A significant two-way interaction between age and importance was also revealed, $F(2, 84) = 5.59$, $p < .01$, $\eta^2_p = .12$. Younger adults rated people with the occupations included in the less important categories as less important than the broadly important items ($M = 2.39$, $SD = 0.54$ and $M = 3.63$, $SD = 1.04$, respectively), $t(23) = 5.73$, $p < .001$, those in the personally important category as more important than the broadly important category ($M = 4.24$, $SD = 0.74$), $t(23) = 2.91$, $p < .01$, and the less important category, $t(23) = 8.17$, $p < .001$. Older adults did not rate those in the broadly important and less important categories differently, $t(19) = 1.44$, $p = .17$, but they did rate personally important items as more important than broadly important items ($M = 4.15$, $SD = 0.85$ and $M = 3.22$, $SD = 0.98$, respectively), $t(19) = 3.93$, $p < .001$, and less important items ($M = 2.98$, $SD = 0.53$), t(19) = 5.77, $p <.001$. There was no effect of age on the ratings given by participants, $F < 1$, $p = .87$.

Discussion

Younger and older participants performed equally well in recalling important information, suggesting that a value-sensitive mechanism may reduce associative memory deficits in older adults. Other processes such as social pruning, in which social networks decrease in size as we age but meaningful connections remain and are often strengthened, could also influence memory for social information among older adults (Charles & Carstensen, 2010). The increase in accuracy throughout the experiment reflects a beneficial effect of repeated testing (and/or of restudying) on memory for associative social information for both younger and older adults (Geraci & Miller, 2013; Meyer & Logan, 2013). Finally, both age groups' ratings of importance were similar to the experimenter-designated categories.

Older adults' memory deficits may be attributed to general slowing of encoding operations (Salthouse, 1996). When younger adults have insufficient time to encode associative information, their performance is expected to be less accurate, though value-directed remembering strategies may still be implemented (cf., Middlebrooks, Murayama, & Castel, 2016). It may be that when younger adults have reduced time to encode information, their encoding experience and later recall performance is similar to that of older adults, an issue we examine in Experiment 2.

Experiment 2

In Experiment 1, younger adults recalled low-value information more accurately than older adults did, but age differences were not present in the recall of high-value information. In Experiment 2, we sought to increase the difficulty of the encoding phase by allowing younger participants less study time, a situation that may perhaps mimic the general slowing that older adults experience in several cognitive domains (Salthouse, 1996). Younger adults' memory for face-name associations is impaired under divided attention (Naveh-Benjamin et al., 2004), but a shorter encoding time may direct younger participants to focus on important information (cf., Middlebrooks et al., 2016). We hypothesized that younger adults would engage in selective memory strategies, which would lead to fewer low-value items recalled (possibly at a level more comparable to older adults with 3s study time), while recall of high value items would be equal to that of older adults with 3s encoding time.

Method

Participants

Twenty-four younger adults (22 females) aged 18-24 (M = 20.00, SD = 1.41) with an educational level of 13.16 years (SD = 1.24) were undergraduates at UCLA and were recruited as in Experiment 1. Twenty older adults (11 females) aged 59-88 (M = 77.24, SD = 7.39) with an educational level of 17.20 years (SD = 1.85) were recruited as in Experiment 1 and were in good self-reported health (M = 8.00, SD = 1.25). None of the participants had participated in Experiment 1.

Materials and Procedure

The materials and procedure were identical to Experiment 1, except that younger adults were given 1s to study each item during the four study cycles. Older adults studied each item for 3s. The research was approved by the UCLA Institutional Review Board ethics committee.

Results

Free recall tests

The results are presented in Figure 2.2. A 2(Importance: broad or personal) × 2(Age: younger or older) × 4(Test number) ANOVA was conducted to assess performance on the free recall tests. There was no significant main effect of age, $F(1, 42) = 2.62$, $p = .11$, $\eta^2_p = .06$. There was a main effect of importance, $F(1, 42)= 7.18$, $p = .01$, $\eta^2_p = .15$, such that personally important information in the was remembered more accurately than broadly important information, (M = 1.67, SD = 1.18 and M = 1.39, SD = 1.19, respectively). There was a significant main effect of test, $F(3, 126) = 38.87$, $p < .001$, $\eta^2_p = .48$, such that performance was more accurate on Test 2 (M = 1.45, SD = 1.06) than on Test 1 (M = 0.51, SD = 0.82), $t(43)$ = 6.37, $p < .001$, and on Test 3 (M = 1.94, SD = 1.12) than on Test 2, $t(43)$ 3.34, $p < .01$, but there was no difference between Tests 3 and 4 ($M = 2.22$, $SD = 0.99$), $t(43) = 1.89$, $p = .37$. No other effects were significant, ps > .61.

Free recall of information associated with less important people was analyzed using a 2(Age group) × 4(Test number) ANOVA, revealing, critically, no main effect of age, $F(1, 42) = 1.39$, $p = .25$, $\eta^2_p = .03$, such that older and younger adults were equally accurate in recalling low-value information. There was also a marginally significant two-way interaction, $F(3, 126) = 2.33$, $p = .07$, $\eta^2_p = .05$. Post hoc t-tests with Bonferroni corrections indicated that younger adults' performance increased at each test. Performance on Test 2 ($M = 1.25$, $SD = 1.51$) was more accurate than on Test 1 ($M = 0.25$, $SD = 0.74$), $t(23) = 4.44$, $p < .001$. Performance on Test 3 ($M = 2.41$, $SD = 3.32$) was more accurate than on Test 2, $t(23) = 2.75$, $p = .01$, and performance on Test 4 ($M = 3.46$, $SD = 4.00$) was more accurate than on Test 3, $t(23) = 2.83$, $p = .01$. Older adults' performance on Test 2 ($M = 0.95$, $SD = 1.54$) was more accurate than on Test 1 ($M = 0.25$, $SD = 0.55$), $t(19) = 2.41$, $p = .03$ and performance on Tests 2 was more accurate than on Test 3 ($M = 1.55$, $SD = 1.82$), $t(19) = 2.45$, $p = .02$, but there was no difference in older adults' performance on Tests 3 and 4, ($M = 1.85$, $SD = 2.62$), $t(19) = 0.75$, $p = .46$.

Cued recall test

For the final cued recall test, a 2(Importance: broad or personal) × 2(Age: young or old) × 2(Characteristic: name or occupation) ANOVA was conducted and revealed a three-way interaction, $F(1, 42) = 4.75$, $p = .04$, $\eta^2_p = .10$ (see Figure 2.2). There was no significant main effect of age, $F < 1$, $p = .76$. Among older adults, there was a main effect of characteristic, $F(1,19) = 8.24$, $p = .01$, $\eta^2_p = .30$, such that names were recalled less accurately than occupations ($M = 1.35$, $SD = 1.53$ and $M = 1.90$, $SD = 1.46$, respectively), but there was no main effect of importance, $F < 1$, $p = .68$. Among younger adults, there was no significant two-way interaction, and there were no significant main effects of importance or characteristic, all *p*s > .21.

For cued recall of items in the "less important" category, a 2(Age: young or old) × 2(Characteristic: name or occupation) ANOVA revealed no main effect of age, $F < 1$, $p = .55$. There was a significant two-way interaction, $F(1, 42) = 7.62$, $p = .01$, $\eta^2_p = .15$, and a significant main effect of characteristic, $F(1, 42) = 6.04$, $p = .02$, $\eta^2_p = .13$, such that occupations were remembered more accurately than names ($M = 4.98$, $SD = 4.25$ and $M = 3.96$, $SD = 3.84$, respectively). Post-hoc t-tests with Bonferroni corrections revealed no differences among younger adults, $p = .80$, while older adults recalled occupations more accurately than names ($M = 5.20$, $SD = 3.99$ and $M = 3.05$, $SD = 3.49$, respectively), $t(19) = 3.15$, $p < .01$.

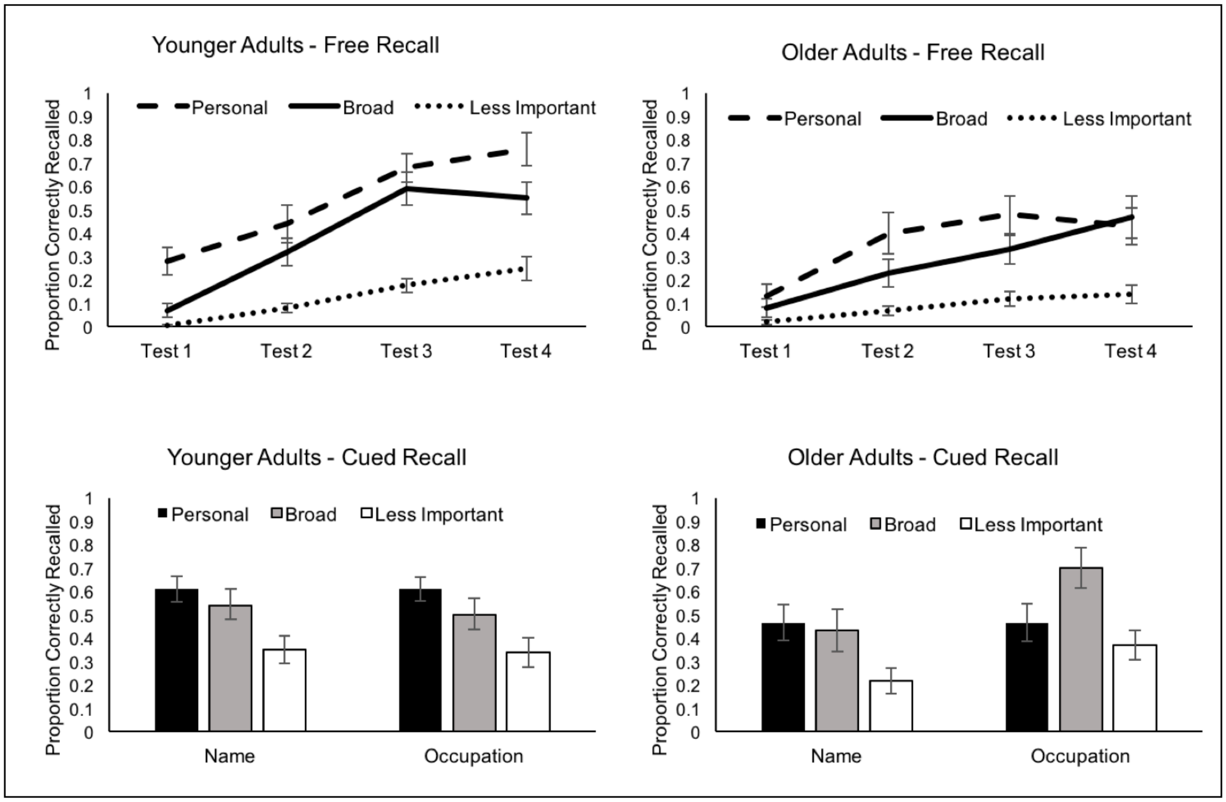

Figure 2.2. The proportion of personally important, broadly important, and less important information correctly recalled by younger adults and older adults in the four free recall test (top panel) and final cued recall test (bottom panel) in Experiment 2. Error bars indicate standard error of the mean.

Importance ratings

As in Experiment 1, after the final cued-recall test, participants were asked to give their own opinions on a 1-5 Likert scale (1 - *not important* to 5 - *very important)* of how important it would be to remember each “type of person” (e.g., sales clerk) presented in the experiment. A 2(Age: younger or older) x 3(Importance: personal, broad, or less important) ANOVA conducted on participants’ importance ratings did not reveal a significant two-way interaction between age and importance, $F < 1$, $p = .75$, but there was a significant main effect of importance $F(2, 84) = 38.25$, $p < .001$, $\eta^2_p = .48$, such that information in the "personally important" category was rated as more important than information in the "broadly important" category, $t(43) = 4.73$, $p < .001$ ($M = 3.93$, $SD = 0.81$ and $M = 3.25$, $SD = 0.89$, respectively), that information in the personally important category was rated as more important than the "less important" category $t(43) = 8.73$, $p < .001$ ($M = 2.65$, $SD = 0.67$), and that information in the broadly important category was rated as more important than the less important category, $t(43) = 4.00$, $p < .001$. There was also a main effect of age, $F(1,42) = 4.43$, $p = .04$, $\eta^2_p = .10$, such that younger adults tended to rate information as more important overall than older adults ($M = 3.44$, $SD = 0.85$ and $M = 3.09$, $SD = 1.02$, respectively).

Discussion

Given very limited study time, younger adults still remember important information (cf., Middlebrooks et al., 2016), much like older adults. Unlike older adults, on the final cued recall test, younger participants remembered information about personally and broadly important people equally, perhaps due to lack of time during study to distinguish among personal, broad, and less important information.

For proper comparison, we collected an additional sample of $n = 20$ younger adults, also undergraduate students at UCLA, who had 3s to encode each item. Younger adults in Experiment 2 were significantly less accurate than the comparison group in the free recall of personally and broadly important information, $F(1, 42) = 7.34$, $p < .01$, $\eta^2_p = .15$, $M = 1.21$ ($SD = 1.14$) and $M = 1.76$ ($SD = 1.14$) respectively. There was no significant difference in the free recall of less important information, $F(1, 42) = 1.54$, $p = .22$, $\eta^2_p = .04$. On the cued recall test, younger adults in Experiment 2 were significantly less accurate in recalling personally and broadly important information, $F(1, 42) = 35.20$, $p < .001$, $\eta^2_p = .46$, $M = 1.70$ ($SD = 0.67$) and

M = 2.70 (*SD* = 0.39) respectively, a pattern which was also present in cued recall of less important information, $F(1, 42) = 9.39$, $p < .01$, $\eta^2_p = .18$, $M = 8.38$ (SD =3.58) and $M = 4.81$ ($SD = 4.06$) respectively. Participants' importance ratings were similar to the categories established by the experimenter, and younger adults rated items as slightly more important than older adults did.

General Discussion

This study examined how younger and older adults remember important social information. Older adults often complain about remembering proper names (Troyer et al., 2006), perhaps related to deficits in associative memory (Naveh-Benjamin, 2000). We investigated whether this deficit is reduced for important social information. As expected, performance improved with repeated study and testing (Geraci & Miller, 2013). Both groups remembered high-value information, but younger adults remembered more low-value information than older adults when given 3s to study each item. Older adults, and to some extent younger adults, remembered occupations more accurately than names (Cohen, 1990). Participants' opinions of importance generally mapped on to the experimenter-designated categories. Taken together, these experiments provide novel insight regarding memory for associative social information. Younger adults were able to remember social information, even when it was not important. In contrast, older adults were able to more selectively remember important information – here, demonstrated not by point value (e.g., Castel, Benjamin, Craik, & Watkins, 2002), but by the likelihood of a potential future use in a social interaction.

Selective remembering may have been encouraged in the present task, but the knowledge that the test will include all of the faces should influence participants to attend to most of the information (if not all of it). Presenting more items may lead to more selective remembering (see also Castel et al., 2016; Mealey et al., 1996), though the small number of important items in this study were chosen to reflect that only a small number of people we meet at a party will be highly important to remember later. The relatively small sample sizes in this study, though similar to previous work, could be increased in future research. Given $n = 44$ for each experiment and an effect size f between moderate and high (.35), our post hoc power to detect differences in the free recall of personally and broadly important information was .86, which is sufficient (Cohen, 1992). A Bayesian analysis of the null effects yielded a small Bayes Factor (the collapsed data from all participants with 3s to study were 2.14 times more likely to fit the null model than the alternative), so future research is needed to determine the boundary conditions of when older adults remember important social information.

Some faces presented in the current study were smiling, others were not. Paired-samples t-tests were conducted to examine whether expression affected free recall of less important information. The only participants significantly affected by the facial expression of the stimuli were the older adults in Experiment 2, who recalled information about 17.08% of the smiling faces in the less-important category ($SD = 24.10$) and 6.13% of the neutral faces in that category ($SD = 8.48$), $t(19) = 2.36$, $p = .03$. This may be related to older adults in Experiment 2 being significantly older than those in Experiment 1, $t(38) = 3.96$, $p < .001$, as effects of positive emotion on memory strengthen into older age (Mather & Carstensen, 2005).

Overall, the present study examined how people of all ages remember important information (Castel, Murayama, Friedman, McGillivray, & Link, 2013), and how the future need to use information is related to its memorability (Anderson & Schooler, 2000). These findings also relate to conditions in which older adults remember source information (May, Rahhal, Berry, & Leighton, 2005; Rahhal, May, & Hasher, 2002) and impressions formed about others

(Cassidy & Gutchess, 2012). Age equivalences in this study may be explained by the benefits of testing across multiple lists, the consideration of future social interaction, and the use of value-directed memory strategies. These processes may also include socioemotional factors and/or cognitive strategies that could be influenced by information importance and memory deficits that accompany cognitive aging.

Study 3

Many of us complain about the difficulty of learning proper names of new people we meet, and we struggle to recall the names of people we have met before. Prior work suggests that remembering a person's name is more difficult than remembering other types of biographical information about that person, such as their occupation or their hobby (Cohen & Burke, 1993; Cohen & Faulkner, 1986; McWeeny, Young, Hay, & Ellis, 1987). In fact, forgetting names is the most common memory complaint among adults over 65 (Fogler, James, & Crandall, 2010; Rendell, Castel, & Craik, 2005; Troyer, Häfliger, Cadieux, & Craik, 2006), and older adults struggle in particular with learning new name information (James, Fogler, & Tauber, 2008; McWeeny et al., 1987). This deficit may be related to a more general associative deficit in memory that increases with age (Naveh-Benjamin, Guez, Kilb, & Reedy, 2004; cf. McGillivray & Castel, 2010; Hargis & Castel, 2017), as older adults often struggle to bind items in memory that are not related, such as name-face pairs (Naveh-Benjamin et al., 2004) and face-spatial location pairs (Bastin & Van der Linden, 2005). It may be that binding name information is particularly difficult because a person's face and name have a fairly arbitrary relationship (Cohen, 1990; Fogler et al., 2010).

Our awareness of our propensity to forget people's names may be different from our awareness about forgetting other types of information: names are difficult to learn (at least in part) due to their arbitrariness (Cohen, 1990; Fogler et al., 2010), but we often feel like we *should* learn them to communicate effectively and avoid embarrassing mistakes later. If we encounter someone we've met before and are unable to recall their name, we may feel particularly embarrassed; indeed, forgetting a new colleague's name may be associated with more social stigma than forgetting, for example, where we placed our car keys. We may chalk the latter up to being busy or not paying attention, whereas the former may be associated with a sort of on-the-spot spotlight effect, in which we overestimate how much our behavior is noticed by others (Gilovich, Kruger, & Medvec, 2002; Gilovich, Medvec, & Savitsky, 2000; Gilovich & Savitsky, 1999).

Feeling that we are in the spotlight can occur when we anchor on our experiences and fail to adjust our feelings to account for others' (Gilovich et al., 2000; see also Epley, Keysar, Van Boven, & Gilovich, 2004). We know we should remember the name of a person we are likely to meet again (see Experiments 1 and 2, this Chapter), so when we forget our colleague's name, we may feel especially embarrassed. Our colleague, however, may not even notice that we have failed to recall their name, especially if our struggle was an internal one: we anchor on our embarrassment and fail to adjust to account for our colleague's feelings. We may feel hesitant to ask our colleague to remind us of their name for fear of offending them, but they may not think twice about it. This experience can create a (perhaps inaccurate) feeling that our mistake is obvious to others – that is, that our memory mistake is in the spotlight. Thus, forgetting a name may loom large in the mind of the learner, but we are all prone to forgetting names.

When trying to remember another's name, participants are particularly susceptible to experiencing the tip-of-the-tongue (TOT) phenomenon (Cohen & Burke, 1993); many of us have experienced the certainty that we know a person's name, only to fail to bring it to mind. In addition to a potential spotlight effect, the awareness of a TOT state may also influence our perceptions of our ability to remember name information (i.e., our metamemory). TOT experiences are particularly prevalent in aging: older adults report experiencing TOT states more often than younger and middle-aged adults do (Heine, Ober, & Shenaut, 1999; James, 2006; Maylor, 1990). The spotlight effect and awareness of TOT experiences may work together to produce an accurate perception of our memory for others' names by making forgetting experiences more salient.

Not all perceptions about ourselves are accurate, however. The better-than-average effect (BTA; Dunning, Meyerowitz, & Holzberg, 1989; Goethals, Messick, & Allison, 1991; Taylor & Brown, 1988; Williams & Gilovich, 2008) occurs when people perceive themselves as performing better than the average person in a given domain. For example, one study found that 90% of drivers in Sweden rated themselves as above average in driving ability (Svenson, 1981). However, by definition, not everyone can truly be better than average: some of us must be average or below average (e.g., Klar & Giladi, 1997). In the current study, it is possible that due to the salience of the embarrassment of forgetting someone's name, participants are less likely to demonstrate the BTA effect for remembering names than for other items. In fact, some may view forgetting names as their own personal deficit (e.g., "I'm so bad with names!").

In other studies of the BTA effect, participants rate themselves highly on socially-desirable traits such as leadership ability (Alicke & Govorun, 2005). They also tend to rate themselves and people close to them (e.g., their family and friends) as higher on socially desirable traits, but these high ratings did not extend to "people in general" (Pedregon, Farley, Davis, Wood, & Clark, 2012; p. 215). That is, the better-than-average effect was present for ratings of oneself and one's family and friends, but not among ratings of the broader population.

In the current study, we adapt Pedregon and colleagues' paradigm to ask younger and older adults to directly assess their own abilities compared to the general population of others their age.

While much of the previous work investigating BTA has focused on younger adult populations, Zell and Alicke (2011) used a sample of participants across the adult lifespan. They asked participants ranging in age from 18 to 85 years about their emotional stability, athleticism, honesty, and other traits, and found that while participants across the adult lifespan did exhibit the BTA effect in many domains, older adults did not rate themselves as better than average in areas such as athleticism, skill at using technology, and physical attractiveness – domains in which older adults, the authors argue, "clearly decline" (p. 1178). In fact, in those abilities and skills, older adults rated themselves worse than average. In the current study, older adults are aware of their propensity to forget names and report is as a common complaint about their memory, but remembering names can also be difficult for younger people as names are highly confusable and arbitrary (Fogler, James, & Crandall, 2010; Rendell, Castel, & Craik, 2005; Troyer, Häfliger, Cadieux, & Craik, 2006).

People are often overconfident in their memory abilities (Carroll, Nelson, & Kirwan, 1997; Koriat & Bjork, 2005). Some work suggests that older adults are more overconfident in their judgments of their own memory abilities than younger adults are (Bruce, Coyne, & Botwinick, 1982; Devolder, Brigham, & Pressley, 1990), while other work suggests younger and older adults' judgments are equally as accurate both in terms of what will later be remembered, and how much may have been forgotten (Connor, Dunlosky, & Hertzog, 1997; Halamish, McGillivray, & Castel, 2011). People across the lifespan believe that their own memory abilities decline with age, and so do others' memory abilities (Hertzog, 2002; Hertzog & Hultsch, 2000).

Older adults' memory complaints have been linked to self-efficacy rather than to actual memory ability (Ponds & Jolles, 1996), but work by Bieman-Copland and Ryan (1998) suggests that in general, people across the lifespan perceive forgetting in old age as caused by lack of ability (see also Ryan & See, 1993). In the current study, instead of asking participants to compare their memory abilities to the average person's, participants compared themselves to others in their particular age group. Asking older adults to compare themselves to other older adults accounts for participants' general awareness that memory does decline with age, while still allowing for a comparison between one's own abilities and others'.

Exhibiting a BTA effect for memory could have consequences. Previous work supports the notion that seeing oneself as better than average can influence behavior: people who believe they are better than average in a given domain are less likely to listen to others' advice, for example (see Gino & Moore, 2007). In contrast, if one views their memory as being *worse* than average, that person may utilize effortful strategies when learning. Interestingly, people often exhibit a better-than-average effect when they perceive the task at hand as easy, but a worse-than-average effect when the task is difficult (Brenner, 2003; Kruger, 1999; Larrick, Burson, & Soll, 2007). In social interactions, the perception that one is worse than average in remembering names or that learning names is particularly difficult could motivate the use of effortful strategies when meeting new people, perhaps to avoid the embarrassment of asking a stranger to repeat his name yet another time. In this case, thinking that one is not better than average could be beneficial.

In the current study, we examine how younger and older adults may (or may not) exhibit the better-than-average effect in their ratings of socially-desirable traits (e.g., honesty), specific memory abilities (e.g., remembering scientific terms), and how well they remember other people's names. Much of the prior work on the BTA effect has been conducted with younger adult samples (e.g., Dunning et al., 1989; Pedregon et al., 2012; Williams & Gilovich, 2008; cf. Zell & Alicke, 2011), but we seek to determine whether the likelihood of seeing oneself as better-than-average on these dimensions differs with age. When assessing their social abilities, we expect that both age groups' responses will indicate a better-than-average effect. We also expect, however, that younger and older adults will not see themselves as better than average in their ability to remember names. Name-related memory failures may easily come to mind due to spotlight and TOT experiences, thus leading to the perception that remembering names is particularly difficult, and we predict that participants will rate their abilities accordingly.

Method

Participants

Participants were 86 younger adults aged 19-25 ($M = 23.23$, $SD = 1.65$) and 71 older adults aged 60-84 ($M = 65.41$, $SD = 4.93$) who were recruited to participate via Amazon Mechanical Turk. Power analyses showed that with these sample sizes for younger and older adults, we could detect an effect of moderate size ($d = .40$) or greater in more than 90% of cases using a two-tailed, one-sample *t*-test (as determining whether participants rate themselves as better-than-average requires comparing their rating to the midpoint of the scale). Participants were paid $2 for their participation.

Materials and Procedure

Participants completed a survey that assessed their perception of their own abilities. They were asked about their overall memory ability, their ability to remember proper names, and their ability to remember scientific terms (e.g., photosynthesis), historical figures (e.g., Napoleon), and locations. The survey also included items assessing participants' perceptions of their honesty, leadership ability, ability to get along with others, and capacity for hard work (see Appendix for all BTA survey items). Each item was constructed so participants would compare themselves to others their age (e.g., "How would you say your memory for names compares to other people your age?") using 9-point Likert scales, labelled "much worse than others my age" on the extreme left of the scale, "the same as others my age" on the middle of the scale, and "much better than others my age" on the extreme right of the scale.

To assess the social impact of forgetting another's name, participants were then asked to imagine that they were talking with someone they did not know well, and that they could not remember that person's name after being told. They were asked to rate on a scale from 1 to 9 how they think that person would feel about them, from "s/he would recognize that we all forget names quite often" to "s/he would be unimpressed and wonder why I couldn't manage this basic social task." After making that rating, participants were then presented with the reverse situation: they were asked to imagine that they were speaking with someone they didn't know well who forgot *their* name after being told, and asked to rate their thoughts on a similar scale (e.g., "I'd be unimpressed and wonder why the person couldn't manage this basic social task"). Finally, participants estimated how many peoples' proper names they know, on a scale from 1 to 1000.

Results

To determine whether the better-than-average effect exists in memory for proper names, we compared participants' responses to the true average of the scale. Because the scale ranges from 1 to 9, placing oneself at the average on any given item would be reflected in a score of 5. Figures 2.3 and 2.4 suggest that on many of the items related to personality traits and memory abilities, participants rated themselves as above average.

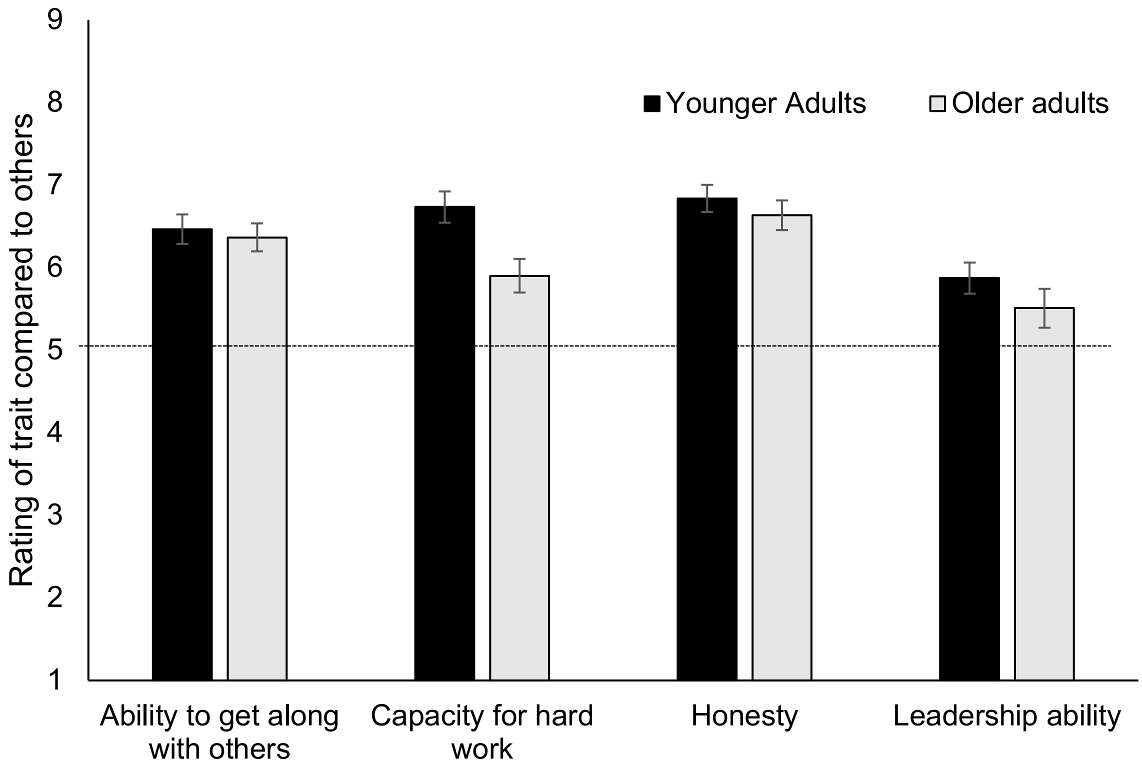

Figure 2.3. Participants' ratings in Study 3 of their own ability to get along with others, their capacity for hard work, their honesty, and their leadership ability. All ratings were compared with other people their age on a scale from 1 (much worse than others my age) to 9 (much better than others my age). The horizonal line represents participants' ratings of themselves as average compared to others their age. Error bars represent standard error of the mean.

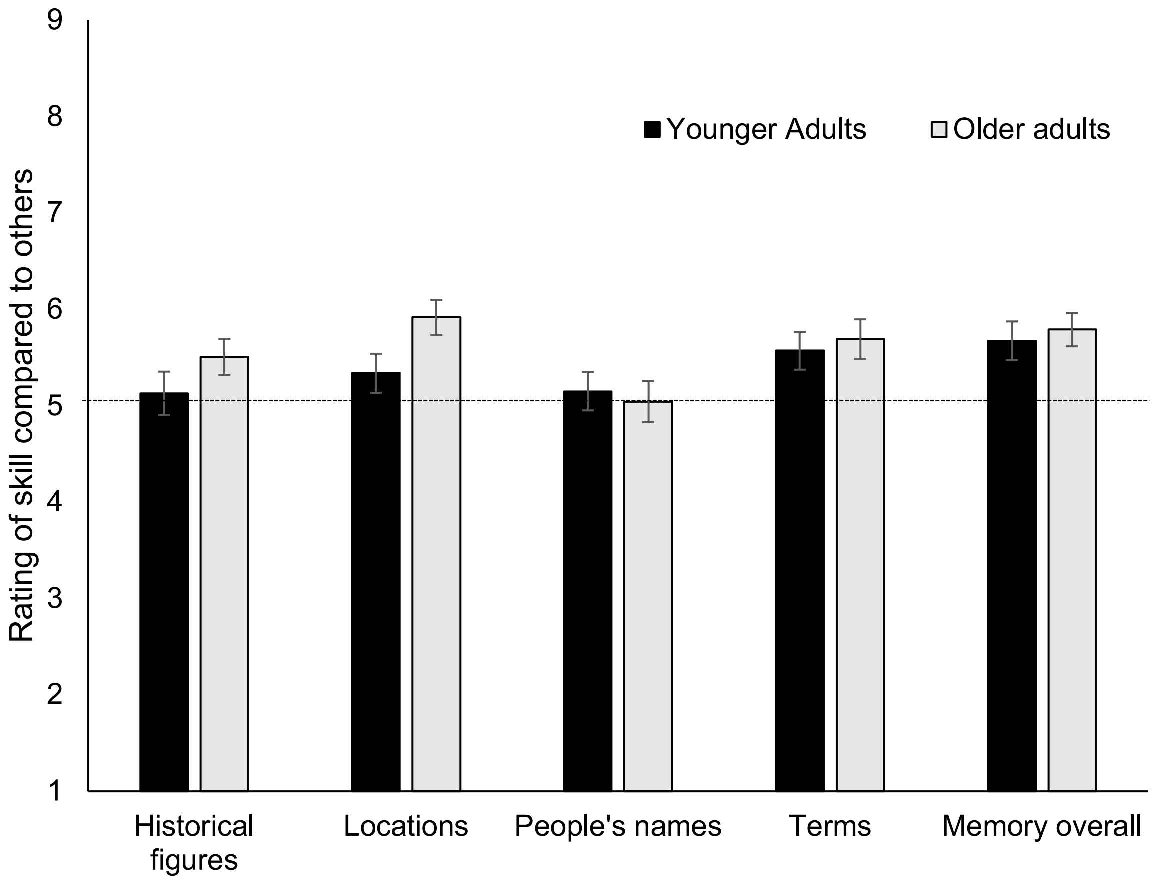

Figure 2.4. Participants' ratings in Study 3 of their ability to remember historical figures, locations, people's names, and scientific terms; also, their ratings of their overall memory ability. All ratings were compared with other people their age on a scale from 1 (much worse than others my age) to 9 (much better than others my age). The horizontal line represents participants' ratings of themselves as average compared to others their age. Error bars represent standard error of the mean.

We conducted a series of one-sample *t*-tests for each age group to determine whether ratings of each item were significantly different from average. These tests revealed that the only item on which older adults participants did *not* rate themselves as above average was when assessing their memory for people's names, $M = 5.04$, $SD = 1.80$, $t(70) = 0.20$, $p = .84$. All other tests revealed better-than-average effects among older adults' ratings. Older participants rated themselves as above average in their capacity for hard work, $M = 5.91$, $SD = 1.72$, $t(70) = 4.24$, $p < .001$, their leadership ability, $M = 5.51$, $SD = 1.99$, $t(70) = 2.15$, $p = .04$, their ability to get along with others, $M = 6.37$, $SD = 1.43$, $t(70) = 8.07$, $p < .001$, and their honesty, $M = 6.63$, $SD = 1.51$, $t(70) = 9.09$, $p < .001$. Older participants also rated themselves as above average when assessing their memory for locations, $M = 5.92$, $SD = 1.54$, $t(70) = 5.02$, $p < .001$, their memory for scientific terms, $M = 5.69$, $SD = 1.74$, $t(70) = 3.45$, $p < .001$, their memory for historical figures, $M = 5.51$, $SD = 1.58$, $t(70) = 2.71$, $p = .01$, and their overall memory ability, $M = 5.79$, $SD = 1.45$, $t(70) = 4.57$, $p = .001$.

There were three items on which younger adult participants' ratings did not illustrate the better-than-average effect, and they were all in the memory domain. Participants' ratings were no different than average when rating their memory for historical figures, $M = 5.13$, $SD = 2.10$, $t(85) = 0.56$, $p = .57$, their memory for locations, $M = 5.34$, $SD = 1.88$, $t(85) = 1.67$, $p = .10$, and, like older adults, their memory for other people's names, $M = 5.15$, $SD = 1.85$, $t(85) = 0.76$, $p = .45$. On all other items, younger participants rated themselves as significantly above average: their capacity for hard work, $M = 6.73$, $SD = 1.76$, $t(85) = 9.14$, $p < .001$, their leadership ability, $M = 5.87$, $SD = 1.75$, $t(85) = 4.63$, $p < .001$, their ability to get along with others, $M = 6.47$, $SD = 1.66$, $t(85) = 8.20$, $p < .001$, and their honesty, $M = 6.84$, $SD = 1.53$, $t(85) = 11.17$, $p < .001$, were all rated as above average. Younger adults rated their memory for scientific terms as above average, $M = 5.57$, $SD = 1.81$, $t(85) = 2.92$, $p = .01$, and their overall memory abilities as above average, $M = 5.67$, $SD = 1.85$, $t(85) = 3.37$, $p = .001$.

Because the pattern of better-than-average effects differed among younger and older adults in the cognitive domain, we conducted a 2 (Age group) x 5 (Memory item: locations, historical information, scientific terms, people's names, and memory overall) analysis of variance (ANOVA). This test revealed no main effect of age, $F(1, 155) = 1.43$, $p = .23$, $\eta^2 = .01$, and no two-way interaction between age group and memory item, $F(4, 620) = 1.16$, $p = .33$, $\eta^2 = .01$. There was, however, a main effect of memory item, $F(4, 620) = 4.60$, $p = .001$, $\eta^2 = .03$, which reflects that there were differences overall among participants' ratings of the memory items.

We explored this main effect of memory item by conducting a series of paired-samples *t*-tests with Bonferroni correction for multiple comparisons. The only significant difference to survive the correction was between participants' ratings of their overall memory abilities and their ratings of their ability to remember people's names, $t(156) = 3.92$, $p < .001$, such that people rated their overall memory abilities ($M = 5.73$, $SD = 1.68$) significantly higher than their ability to remember names ($M = 6.10$, $SD = 1.82$), $t(156) = 3.92$, $p < .001$.

We then conducted a series of Spearman correlations among participants' responses to the survey items. Many memory processes decline across the older adult lifespan (e.g., McCabe, Roediger, McDaniel, Balota, & Hambrick, 2010; see also Craik & Salthouse, 2008), but because participants were asked to compare their performance to other participants their own age, we did not necessarily expect that older adults' ratings of their memory accuracy would correlate negatively with age. Correlations are reported below in Tables 2.1 and 2.2. We also calculated the extent to which each participant's rating of their ability to remember others' names deviated from the average (i.e., a negative score indicates a lower-than-average rating, and a positive score indicates a higher-than-average rating). This deviation score did not correlate with age among younger adults, $r_s = .036$, $p = .74$, or older adults, $r_s = -.039$, $p = .75$.

When asked to rate how they felt when another person forgot their name and when they forgot another's name, both younger and older adult participants rated the first scenario significantly more negatively than the second. We conducted a 2 (Age group: younger or older) x 2 (Person forgetting: self or other) mixed ANOVA, which revealed neither a significant two-way interaction, $F(1, 155) = 2.19$, $p = .14$, $\eta^2 = .01$, nor a main effect of age, $F(1, 155) = 0.45$, $p = .50$, $\eta^2 < .01$. There was, however, a significant main effect of the person forgetting, $F(1, 155) = 79.33$, $p < .001$, $\eta^2 = .34$, such that participants gave significantly more positive (i.e., lower) ratings when asked about another person forgetting their name ($M = 3.32$, $SD = 2.07$) than when they were asked about their own failure to recall another person's name ($M = 4.83$, $SD = 2.19$).

We also sought to assess whether forgetting names may be associated with an unpleasant emotional reaction (e.g., embarrassment) that is not present when another forgets their name, and whether this feeling is associated with greater awareness of the difficulty of remembering names. We first created a difference score by subtracting ratings of how participants feel when someone forgets their name from how participants feel when they forget another's name. Higher ratings on the original scale are associated with feeling worse, so a higher difference score in this case would indicate participants feeling worse when they forget another's name than when someone forgets their name. We conducted a Spearman correlation between this difference score and younger participants' ratings of their ability to remember people's names, which did not reveal a significant correlation, $r_s = -.14$, p = .22. However, among older adults, there was a significant negative correlation between the difference score and participants' rating of their ability to remember people's names, $r_s = -.41$, $p < .001$. Finally, younger and older adults estimated that they knew approximately 379.50 (*SD* = 227.35) and 436.15 (*SD* = 247.77) names respectively; this difference was not statistically significant, $t(155) = 1.49$, $p = .14$.

Discussion

The current study illustrated the better-than-average (BTA) effect in several of younger and older adults' ratings of their social and memory abilities. Participants in both age groups, however, rated themselves as no different from average in remembering others' names, supporting the argument that at least older participants are more aware of their propensity to forget names than other information. Even though older adults experience name recall failure more often than younger adults do (James, Fogler, & Tauber, 2008; McWeeny et al., 1987), they are aware that this experience may be "par for the course" relative to their age group. While prior work has found older adults to not rate themselves as above average in areas in which they face clear deficits (e.g., athleticism; Zell & Alicke, 2011), the current work establishes a domain in which neither younger nor older adults see themselves as above average.

Younger adults rated themselves as no different from average on their ability to remember historical figures and location information, while older adults rated themselves as above average compared to others their age. These findings support prior work indicating age-related differences in knowing how one's memory works (e.g., Bruce, Coyne, & Botwinick, 1982; Devolder, Brigham, & Pressley, 1990); though both age groups in the current study rated themselves as above average on many domains, older adults did so on more items than younger adults. The current study illustrates potential boundary conditions for the BTA effect: perhaps when the memory error is particularly salient with highly-available examples and easily-imaginable consequences (e.g., embarrassment or a low exam score), participants are more accurate in their ratings of themselves compared to others than when the memory error is less salient. Among younger adults, instances of forgetting information in their history courses may be easy to recall, and these errors may be made even more salient by feedback in the form of exam scores (this does not explain, however, why younger adults rate their memory for scientific terms as above average). Among older adults, perhaps examples of forgetting history or science information are less salient than examples of forgetting names, and their ratings follow this pattern.

Across the lifespan, we may see our propensity to forget names as an embarrassing personal deficit, but when others forget our name, we see it as normal: participants in the current study rated their forgetting another's name as worse than if another person forgot their name. Further, there was a significant negative correlation between older adults' ratings of the relative unpleasantness of forgetting another's name (compared to another person forgetting their name) and their ratings of their own ability to remember names. Forgetting a name can be an embarrassing and salient experience, and older adults may be especially attuned to this error (in fact, forgetting names is a common memory complaint by older adults, Troyer et al., 2006). Older participants who rated their ability to remember names more poorly were more likely to feel worse when they forget another's name than when another person forgets theirs. This was not the case for younger adults, however. Perhaps older adults' concern about their forgetting experiences led them to be more aware of their struggle to remember names, while younger adults may not be especially concerned with forgetting names as they also see themselves as average in remembering historical figures and location information.

We also examined potential relationships among participants' age, their ratings of their memory for names, and their other memory abilities. The correlations in Tables 2.1 and 2.2 indicate that among both younger and older adults, age did not correlate with any of the participants' ratings. Younger adults' ratings of their ability to remember names were positively correlated only with the ability to get along with others, suggesting that people who see themselves as more socially apt may see themselves as better at remembering names (perhaps trying to remember someone's name is a good way to get along with that person). Among older adults, in contrast, memory for people's names was positively correlated with all items except age and honesty, indicating that the social and cognitive constructs examined here may be part of a more global self-assessment of cognitive health.

Younger adults estimated that they knew approximately 379.50 names of other people, and older adults estimated that they knew approximately 436.15 names. Although this difference was not statistically significant ($p = .14$), the pattern of responses is interesting, especially when considering the scale on which participants reported. That the scale provided was from 0 to 1000 names suggests the potential for participants' anchoring between 30-50% of the scale (Scheck, Meeter, & Nelson, 2004; see also Hertzog, Saylor, Fleece, & Dixon, 1994), perhaps taking the anchor as a hint about how to respond (Epley, 2004). Future studies can assess under what conditions our awareness of our memory for names can be affected by the scale on which we report.

Prior work suggests that the BTA effect can be attenuated when the items participants are rating are seen as unambiguous (Dunning et al., 1989). It may be that rating one's honesty or overall memory is a fairly ambiguous and broad task, while rating one's ability to remember names is, in comparison, unambiguous and specific (and perhaps examples of remembering scientific terms and historical information are clearer to younger adults than to older adults). Also, remembering names can be challenging (especially for older people; Fogler et al., 2010;

Rendell et al., 2005; Troyer et al., 2006), and participants are less likely to rate themselves as above average on a difficult task than on an easy one (Kruger, 1999).

In addition, participants' tendency to see themselves as better than average is stronger when they rate attributes seen as relatively important (e.g., being honest) than relatively unimportant (e.g., being outgoing; Brown, 2012). Participants in the current study do show the BTA effect for desirable traits like honesty but not for remembering names. However, this pattern cannot be fully explained by participants' belief that remembering names is unimportant – we do meet new people and encounter acquaintances throughout the lifespan, so remembering names remains a desirable skill (though substantial evidence suggests that spending time with loved ones becomes more important than meeting new people in older age; Fredrickson & Carstensen, 1990). In fact, some prior work suggests equivalence in younger and older adults' memory for names that are deemed important to remember later; older adults may have some ability to compensate during a difficult associative memory task by focusing on the social information that is most important to them (Hargis & Castel, 2017). Other work suggests that individuals see themselves as above-average in abilities that are common but not in abilities that are uncommon (Moore, 2007), but this account may not explain the current findings, as remembering names is a common activity.

In sum, the current study suggests that younger and older adults are susceptible to believing themselves to be above average on several dimensions in social and cognitive domains. There is, however, an exception to the pattern: younger adults see themselves as average in remembering historical and location information, and participants of both age groups see themselves as no different from average in their ability to remember other people's names. The subjective experience of forgetting someone's name may have social implications different from forgetting other types of information, and the internal (and sometimes embarrassing) struggle to remember someone's name may have created a particularly salient memory trace that participants recalled while rating their own abilities. While older adults experience "feelings of forgetting" that can often represent actual forgetting (Halamish et al., 2011), the present research shows that both younger and older adults are aware that forgetting names, while frustrating, can be an experience that is not specific to themselves alone. Perhaps if we perceive our memory errors to occur while others are paying attention (creating a spotlight effect, Gilovich et al., 2002; Gilovich et al., 2000; Gilovich & Savitsky, 1999), we create a more accurate representation of our memory's fallibility and are less likely to be overconfident in our abilities.

Experiment 4

The ability to remember pairs of unrelated information is helpful when learning a person's name, where we placed our car keys, or a new word in a foreign language. Extensive work has documented this type of learning using a paired-associate learning (PAL) paradigm in which a cue word and a target word are presented together during study, and at test, only the cue word is presented and participants are asked to recall the target word. Several variables have been shown to influence this relationship, such as the concreteness of the cue and target words (Paivio, 1965), the imageability of the cue and target words (Papagno, Valentine, & Baddeley, 1991), and the degree to which the cue and the target are semantically related (Arenberg & Robertson-Tchabo, 1977). The number of opportunities for participants to learn the pairs is also worth considering (Peterson, Saltzman, Hillner, &Land, 1962); Theide (1999) underscores the importance of more than one study-test trial when examining how participants learn pairs of associated information.

PAL can be influenced by our motivation to learn the items (e.g., in this chapter, Experiments 1 and 2, and in Chapter 3, Experiments 1 and 2), but sometimes pairs can be difficult to learn due to characteristics of the pairs themselves (e.g., concreteness; Paivio, 1965) and/or characteristics of the participants (e.g., older age; Rast & Zimprich, 2009; Service & Craik, 1993). Indeed, older adults often struggle to remember untreated word pairs (Arenberg & Robertson-Tchabo, 1977; Naveh-Benjamin, 2000; Service & Craik, 1993); but when unrelated associative information is valuable in some way, older adults can remember than important information as well as younger adults, even if they face deficits in remembering less-important associated items (e.g., Hargis & Castel, 2017; Hargis & Castel, 2018; see also Treat & Reese, 1976 for similarities in younger and older adults' PAL). Thus, there are several factors influencing PAL, and some pairs can be more important to learn than others given our goals. The current study assesses how differences in motivation may interact with age-related differences in ability to learn foreign language pairs.

One's motivation to learn information, of course, depends on how one intends to use that information. For example, a younger adult and an older adult may both seek to learn Spanish vocabulary words: on its face, their desired outcome seems identical (Hargis, Siegel, & Castel, 2019). However, the younger adult may seek to learn this information with the goal of performing well on a test in Spanish class, while an older adult's motivation may be to help his new neighbors from Guatemala feel more welcome by greeting them in Spanish. That is, the particular goal of learning Spanish is the same, but motivation differs based on the individual's perspective. Socioemotional selectivity theory (Carstensen et al., 1999) predicts that older adults pursue fewer goals related to acquiring knowledge, instead preferring goals that facilitate the growth of social bonds. Learning foreign language vocabulary can be important for people all ages when they travel abroad; it can be considered a goal with both social and knowledge-based components that is shared by younger and older adults. We aim to better understand how knowledge is acquired in service of a goal that has a notable social component. To that end, the current study was designed to determine how learning of important foreign vocabulary words may differ between younger and older adults.

Travelling to a foreign country in which most locals do not speak one's own language can motivate individuals across the lifespan to learn new vocabulary. In this instance, it may be important for one to know words for basic social interactions (e.g., "hello," "thank you"), or perhaps words that could be needed if difficulty arises (e.g., "doctor," "embassy"). While the translations for these words may often be featured in guidebooks, introductory foreign language courses, or popular language learning mobile applications (e.g., Duolingo), it may also be convenient to memorize a few important words before arriving. The current task examined how younger and older adults learn foreign language words and their English translations.

In addition to being realistic given the backstory of a foreign trip and fitting the needs of the communication component of this task (i.e., it was designed such that participants would need to consider their ability to communicate with others on their trip), foreign language nouns paired with English words reduce the likelihood that a participant could use a sophisticated mnemonic strategy during study (Zerr et al., 2018). For example, it is challenging to imagine a picture or story representing that the Swahili word for "nurse" is "muuguzi," but an image could be more easily created for the English pair "dog : spoon." If there is no inherent structure or strategy that lends itself to studying the word pairs, it may be that the participant's own perception of how important each item is to remember is a stronger guide of their attention during study (in addition, perhaps, to factors such as word length or fluency), which is enhanced by the more explicit, experimenter-designated value component incorporated into current study (especially in Experiment 5). Further, Swahili is not as commonly encountered among most American participants as, for example, Spanish or French are, which reduces the likelihood of prior knowledge impacting participants' performance (see Nelson & Dunlosky, 1994 for a full discussion of the benefits of using Swahili-English pairs in a PAL task).

Older adults often struggle to bind associated items in memory (Arenberg & Robertson-Tchabo, 1977; Naveh-Benjamin, 2000; Service & Craik, 1993). The current task may require particular engagement of associative strategies with which older adults struggle, due perhaps to the lack of obvious strategies to use during encoding and the unfamiliarity of the Swahili pairs. Therefore, an overall associative deficit is predicted for older adults' memory performance, such that they perform less accurately overall than younger adults do. Perhaps more interesting is the possible connection between perceived importance of learning a word and its later recall. If there is a relationship between the two, such that a higher importance rating of an item is related to higher likelihood of recalling that item, this provides support for the role of personal perceptions of importance guiding memory for difficult-to-learn items. However, if there is no relationship between importance and recall, it may be that all words are considered equally important (meaning, essentially, that no words are more valuable than others), or that importance does not affect learning in this type of task.

In the current study, participants were asked to imagine that they were visiting Kenya, where many of the local people speak Swahili. Rather than being told by the experimenter which words were important to remember (as has been the case in many value-directed remembering studies using relatively naturalistic materials, e.g., learning important allergens in Middlebrooks et al., 2015 and learning important social information in Experiments 1 and 2 in this Chapter), participants rated how important it would be for them to know the Swahili translation of each English word. After these ratings, participants studied pairs of words (e.g., “fever : homa”) and completed a cued-recall memory test, which was repeated for a total of two study-test cycles.

Method

Participants

Twenty-six younger adults aged 18-22 years (M_{age} = 19.88, SD_{age} = 1.24; 25 female) who were undergraduates at the University of California, Los Angeles (UCLA) were recruited for this study, and were given course credit for their participation. Twenty-six older adults aged 61-89 years (M_{age} = 74.61, SD_{age} = 7.03; 12 female, one did not report) were recruited from the Los Angeles area, and received $10 per hour for their participation. Most older adults had received a college (42.31%) or a graduate school (38.46%) education.

Materials and Procedure

Participants were asked to imagine that they would soon take a trip to Kenya, a country in which many people speak Swahili. They were told that before they leave on their trip, it would be helpful to know some Swahili words. Participants were then given the opportunity to rate the words that they would later study on a scale of how important it would be to remember the Swahili translation of the word on their trip, from 1 (not at all important to know for the trip) to 7 (very important to know for the trip). Participants did not see the Swahili translation at this time; they only rated the importance of knowing the Swahili translation of each English word.

The stimuli were in four different (experimenter-designated) categories, with six words per category. The categories were basic conversational words (e.g., “hello”), words that would be helpful in travelling (e.g., “money”), food words (e.g., “meat”), and health-related words (e.g., “fever”). These categories were not made explicit to the participants, but participants may have perceived the category structure as the words were chosen to be similar within-category but not similar between-categories. The words ranged in length from one to six syllables, and were chosen because they were words that one would likely see in a guidebook or a basic Swahili-English translation book; commonly used words were excluded from the stimuli set if they were cognates between English and Swahili (e.g., “hotel : hoteli,” while potentially important to learn for a trip, was not included). The words chosen were, by design, common in the English lexicon; the average log frequency of the English words was 10.30 (*SD* = 1.64). The English words were an average of 6.00 letters in length (*SD* = 2.59). (See Table 2.3 for the full set of Swahili-English pairs in Experiments 4 and 5.)

Once participants rated all of the words, they studied each English word paired with its Swahili translation. Participants were told before they studied that they would later be presented with the Swahili word and asked to recall the English word. The test was constructed in this way to mirror communicating with someone who speaks a new language in a different country: often the speaker may use a word in a foreign language in conversation, and difficulty may arise when one attempts to retrieve the English language translation of that word. This type of retrieval could also be necessary when reading city maps or restaurant menus.

Participants studied each of the 24 pairs (e.g., “fever : homa”) for 5s, presented one at a time in randomized order. Participants were then presented with each Swahili word (in randomized order) and asked to recall the English translation of that word to the best of their ability. There was no explicit feedback during the test phase. After the test, participants were presented with each pair again (in newly-randomized order), again for 5s each, before moving on to another cued-recall test with the same cues as the initial list, presented in randomized order.

Results

The goal of the current study was to determine whether participants' ratings of importance of learning foreign language vocabulary words are related to their recall of the English translations of those words. Responses were scored such that slight misspellings were counted as correct (e.g., "embassey" and "embassy" were both accepted, as were both "vegetable" and "vegetables"). To examine differences between younger and older adults' cued recall accuracy across the task and across different categories, a 2(age group: younger vs older) x 2(test: 1 vs 2) x 4(category: basic communication, food words, health words, travel words) mixed analysis of variance (ANOVA) was conducted. The test revealed a main effect of age, $F(1, 50) = 34.59$, $p < .001$, $\eta^2 = .41$, such that younger adults recalled more items on average than older adults did across the task (see Figures 2.5 and 2.6). There was also a main effect of category, $F(3, 150) = 4.50$, $p = .01$, $\eta^2 = 0.08$, which post-hoc *t*-tests suggest was driven primarily by the health-related words being recalled less accurately than the travel-related words, $t(25) = 4.00$, $p < .001$; all other *p*s > 0.02 (failed to reach significance after Bonferroni correction for multiple comparisons).

There was main effect of test, $F(1, 50) = 249.72$, $p < .001$, $\eta^2 = .75$, such that performance was more accurate on Test 2 than on Test 1; however, younger adults' performance improved to a larger extent than older adults' did: there was a significant interaction between test and age group, $F(1, 50) = 35.33$, $p < .001$, $\eta^2 = .10$. Follow-up *t*-tests illustrated that both groups did improve between Tests 1 and 2, ($t(25) = 14.53$, $p < .001$ for younger adults, and $t(25) = 7.22$, $p < .001$ for older adults), but the magnitude of the difference is not equivalent for both age groups: younger adults improved to a greater extent (from $M = 33.49$, $SD = 15.70$ on Test 1 to $M = 68.75$, $SD = 21.99$ on Test 2) than did older adults (from $M = 16.51$, $SD = 10.31$ on Test 1 to $M = 32.85$, $SD = 19.30$ on Test 2).

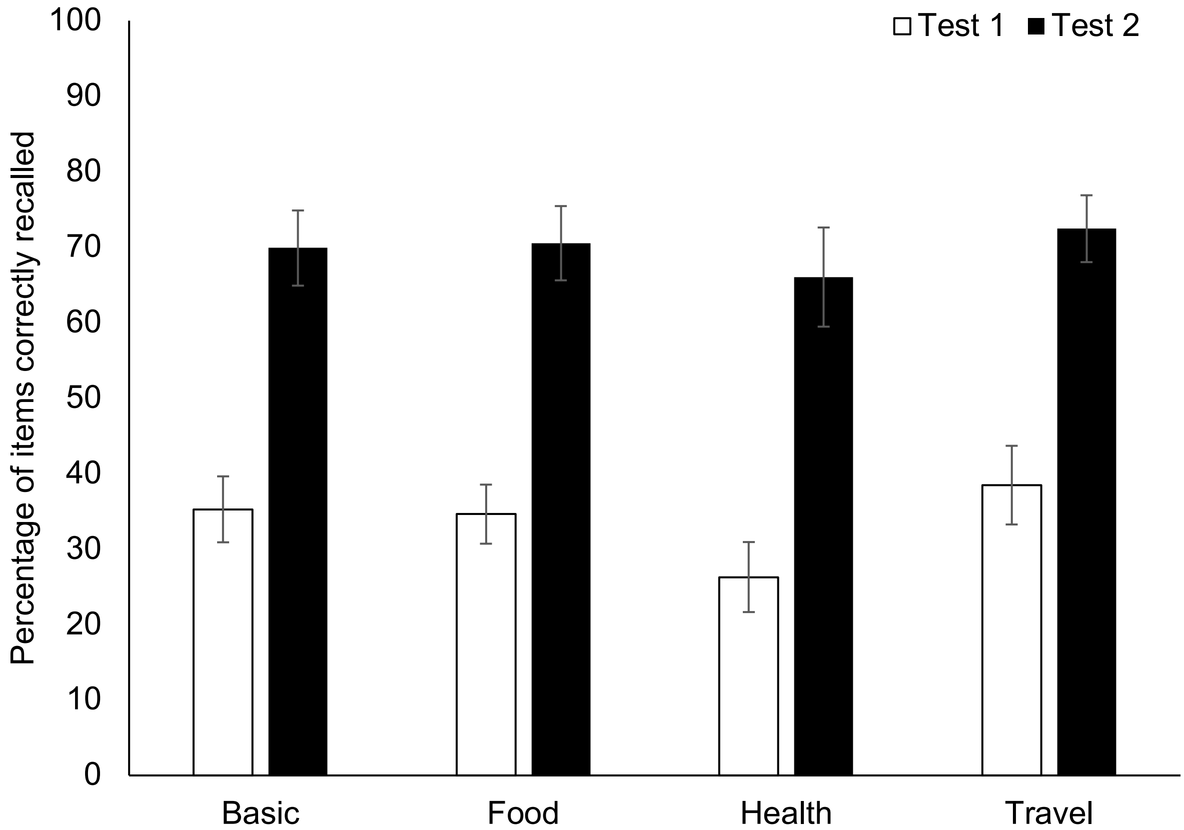

Figure 2.5. Younger adults' cued recall performance by category across two tests (in Experiment 4). Error bars represent standard error of the mean.

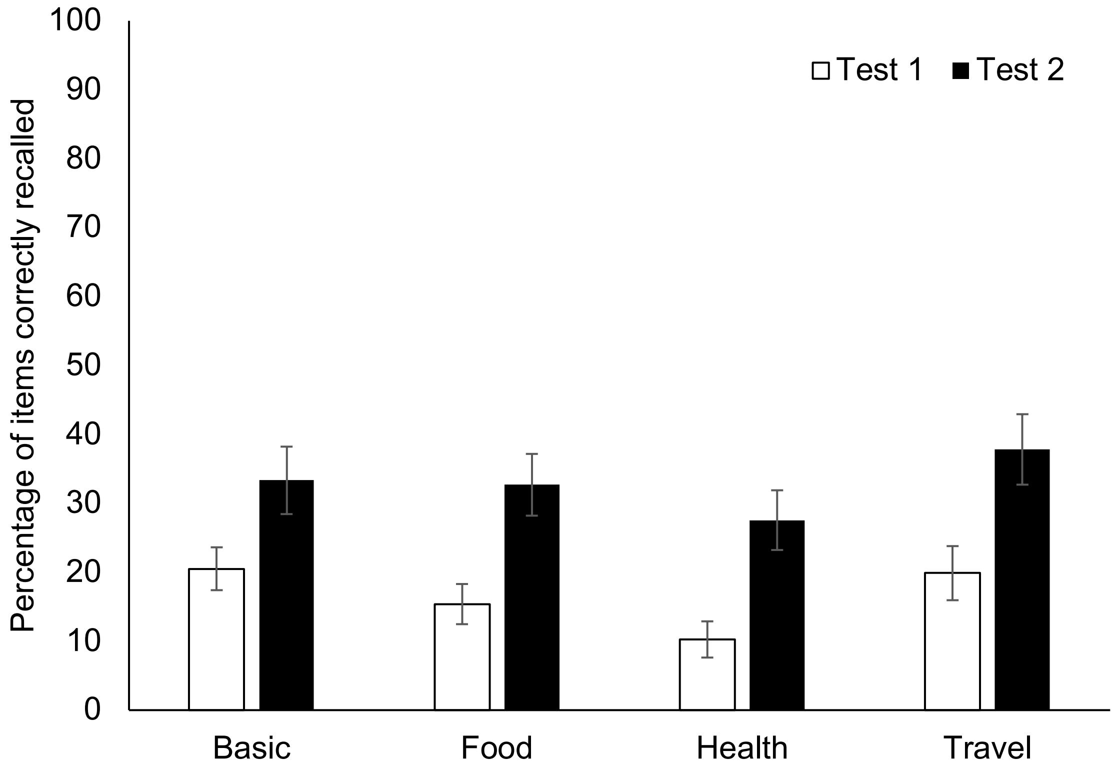

Figure 2.6. Older adults' cued recall performance by category across two tests (in Experiment 4). Error bars represent standard error of the mean.

A 2 (age group) x 4 (category: basic, travel, food, health) mixed-factorial ANOVA was conducted on initial importance ratings to determine whether certain categories of words were rated as more important to learn than others. This test revealed no main effect of age, $F(1, 50) = 0.17$, $p = .69$, $\eta^2 = .01$, no main effect of category, $F(3, 150) = 1.52$, $p = .21$, $\eta^2 = .03$, and no interaction between age and category, $F(3, 150) = 0.87$, $p = .46$, $\eta^2 = .02$. There were no significant differences between the categories in their importance ratings, and there were no significant differences between how young and old rated the words in these categories: all words were rated as relatively important (see Figure 2.7).

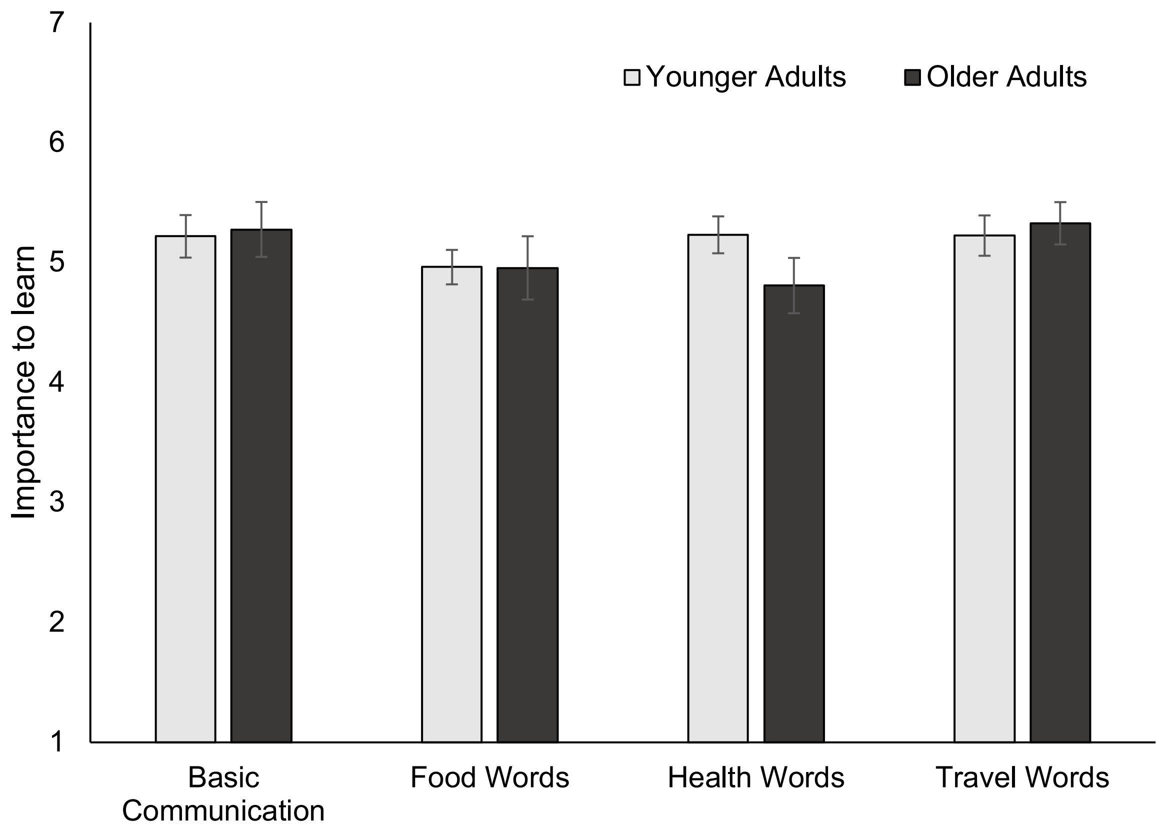

Figure 2.7. Younger and older adults' ratings (in Experiment 4) of how important it would be to learn the Swahili translation of each English word, separated by category. Error bars represent standard error of the mean.

Importance ratings were correlated with accuracy scores to determine whether words rated as important were in fact more likely to be accurately recalled than those that were rated as less important. It is worth noting that participants did not see the Swahili word when they made importance ratings, so they were not likely to know how difficult it would be to learn the Swahili word for "doctor," for example, thus making their importance rating more of a true rating of importance rather than a rating of importance weighted by difficulty of learning the Swahili word. Therefore, importance ratings were not expected to be strongly affected by the difficulty of the to-be-learned pair. For older adults, there was only a significant correlation between importance ratings and accuracy for the words in the basic communication category, Spearman's rho = -.51, $p < .01$, such that words given higher importance ratings were actually less likely to be recalled by older adults. All other correlations were non-significant, *p*s > .30. Among younger adults, the same correlations were conducted, revealing a significant positive relationship between importance ratings and accuracy for food-related words (e.g., "fruit"), $r_s = 0.48$, $p = .01$. All other relationships were not significant, *p*s > .17.

Discussion

As expected, younger adults were more accurate than older adults in learning the English translations of Swahili words. Both groups were able to learn with task experience and performed more accurately on the second test, once they had been given a re-study opportunity. Younger adults' performance increased more between Tests 1 and 2 than older adults', suggesting that younger adults benefited more from the repeated study-test opportunity than older adults did. There was a difference in recall performance across the different categories of words, such that words associated with travel (e.g., "embassy," "identification") were recalled more accurately than those associated with health (e.g., "doctor," "nurse"). This particular difference was not predicted, as we anticipated that both age groups (particularly older adults) would rate the health-related words as highly important to remember and then recall them more accurately than other types of words. In fact, most categories of words were rated as fairly important to remember and ratings did not differ between age groups.

These results suggest that both age groups perceived the set of words to be equally important to remember for their trip, but younger adults were significantly more successful in remembering those words than were older adults. Age-related differences in associative memory are found in many domains, including memory for word-non-word pairs (Naveh-Benjamin, 2000), a finding that is highly similar to the current study as the Swahili words were totally unfamiliar to the participants, essentially acting as non-words.

It is worth noting, however, that the participants' subjective ratings of importance did not correlate with their recall of the different categories, except for the negative correlation among older adults' ratings of the basic communication words and recall, and a positive relationship between younger adults' importance ratings of food-related words and their recall of those words. It could be possible that for older adults, basic words were considered only somewhat important during the importance-rating stage of the task, but those ended up being relatively easy to learn, thus leading to the negative correlation. This pattern, however, is not fully supported by older adults' recall accuracy scores, as basic communication words were not remembered more accurately than words in the other categories (indicating that they were not easier to learn than the other types of words). This relationship is also not completely explained by the length of the words: the target words in the basic category were an average of 5.33 letters long (SD = 2.07), but so were the words in the food-related category (M = 5.33 letters, SD = 2.34). (The health-related words were an average of 6.00 letters long, SD = 2.00, and the travel-related words were an average of 7.33 letters long, SD = 3.72.) A potential explanation for this negative correlation could also be that participants' ratings were not sensitive to the possibility of within-category interference: it may seem important to know "yes" and "no," for example, but those English words have a strong semantic relationship that studying both may create the possibility for confusability and interference in memory. Experiment 5 more directly assesses differences in importance and their potential influence on recall.

As reported above, the average frequency of the English words was 10.30 (SD = 1.64). There was a marginal difference in word frequency among the categories: a one-way ANOVA revealed a marginal main effect of log HAL frequency, $F(3, 20) = 2.82$, $p = .07$, and post-hoc tests revealed that the only significant difference (after alpha correction) was that the basic words were marginally more frequent in the lexicon than health-related words, $t(23) = 2.69$, $p = .06$. These differences do not fully explain the reported differences in memory and the correlations between importance ratings and recall.

Importance ratings suggest that each category presented in the current study was fairly important to learn. Because all words are considered relatively important, there is not a possibility to execute a value-based study strategy; selectivity for high-value words can only be present if there are low-value words to avoid (or, at least, to de-prioritize; Castel et al., 2002). It is also likely that when travelling, we do encounter words that we are likely to need for our basic needs and preferences, making them relatively more important to learn than other words that might be equally as common in the lexicon but less important for travel specifically. To examine whether a higher-contrast value-based structure influences learning of foreign language words among younger and older adults, we conducted Experiment 5.

Experiment 5

In Experiment 4, participants studied a set of words that could all be considered valuable to learn for a trip. Even the words that were rated lowest on the importance scale, such as food-related words, were still perceived as relatively important to learn (see Figure 2.7). To create a paradigm in which value-based strategies can be executed, some items must be higher-value and others lower-value (e.g., Castel et al., 2002). To allow participants to execute a value-based strategy, Experiment 5 utilized a subset of words from Experiment 5, as well as a new set of words that are similarly frequent in English to those in Experiment 4, but were expected to be less important to learn for a foreign trip (e.g., "arm" and "pen"). With a more obvious value-based structure in place, we expected that younger and older participants would learn the translations for high-importance items (e.g., "doctor") more accurately than the words that are less important; age group differences in memory for the high-importance items were expected to decrease while younger adults were expected to recall the lower-importance items significantly more accurately than older adults did.

Results from Experiment 4 suggest that younger adults substantially outperform older adults in this word-learning task, and that younger adults improve more than older adults with an additional learning opportunity. Given a more explicit value structure, older adults' performance is still expected to be less accurate than younger adults, but older adults may be able to execute a value-based strategy for the more important words and thus decrease the gap between younger and older adults' recall of the high-value items (creating an age by value interaction, such that the difference between younger and older adults' performance will be smaller for higher-value categories of words than for lower-value categories of words). Older adults may also be able to utilize task experience to improve their memory for high-value information with an additional study-test opportunity, as value-directed remembering strategies often develop with task experience. Younger adults are expected to improve in their recall of the information with task experience (both lower- and higher-value), consistent with performance in Experiment 4.

Method

Participants

Twenty-six younger adults aged 18-26 years (M_{age} = 20.31, SD_{age} = 1.95; 21 female) who were undergraduates at UCLA were given course credit for their participation. Twenty-six older adults aged 62-85 years (M_{age} = 75.54, SD_{age} = 7.92; 13 female) were recruited from the Los Angeles area, and received $10 per hour for their participation. Most older adults had received a college (30.77%) or a graduate school (50%) education. None had participated in Experiment 4.

Materials and Procedure

The procedure was identical to Experiment 4. The materials were modified slightly. Participants studied words from two of the categories from Experiment 4 (e.g., food words and travel words). These words are considered relatively high-importance items to learn for the trip, based on the high ratings given by participants in Experiment 4. To create a set of 24 to-be-learned items to match the number of items in Experiment 4, participants also studied two additional categories of six words considered to be of lower importance to learn for a trip: common objects (e.g., “desk”) and body parts (e.g., “arm”). The categories were chosen to include words that are highly common in English and are also words that would likely be learned in an introductory foreign language course. The HAL frequency of the object and body part categories were high, similarly to the categories of words in Experiment 4 (M = 9.78, SD = 0.71 and M = 10.48, SD = 0.69, respectively; both within one standard deviation of the HAL frequency of the English words used in Experiment 4).

As in Experiment 4, participants read the description about their trip to Kenya before rating the importance of knowing the Swahili translations of 24 English words. After rating the words, participants studied each English-Swahili pair in random order for 5s each. At test, participants were presented with the Swahili word asked to recall the English translation. This process repeated for List 2, which contained the same words as List 1.

Results

Figures 2.8 and 2.9 suggest that participants improved substantially between Tests 1 and 2, and that there are differences in recall between the “less important to learn” categories of body parts and common objects and the “more important to learn” categories of food-related words, basic communication words, health-related words, and travel-related words.

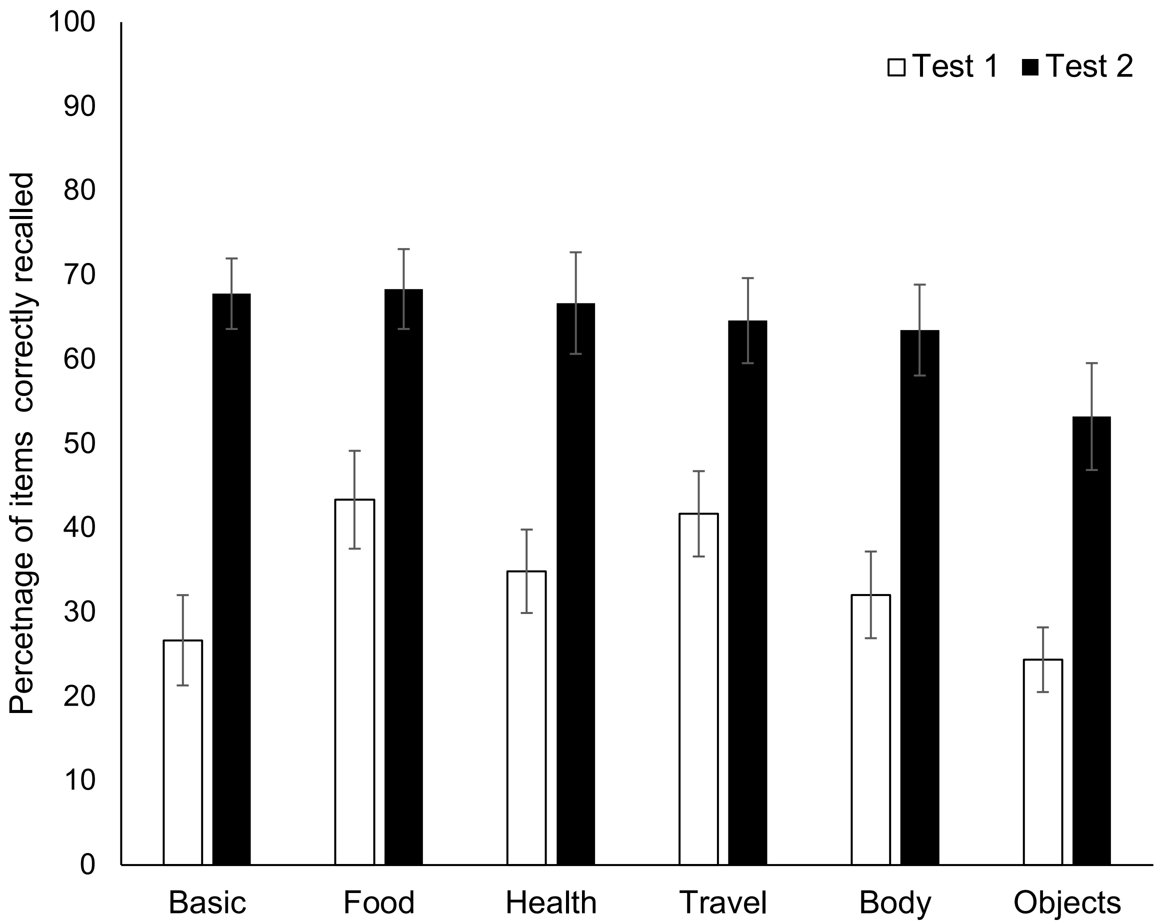

Figure 2.8. Younger adults’ cued recall performance by category across two tests (in Experiment 5). Error bars represent standard error of the mean.

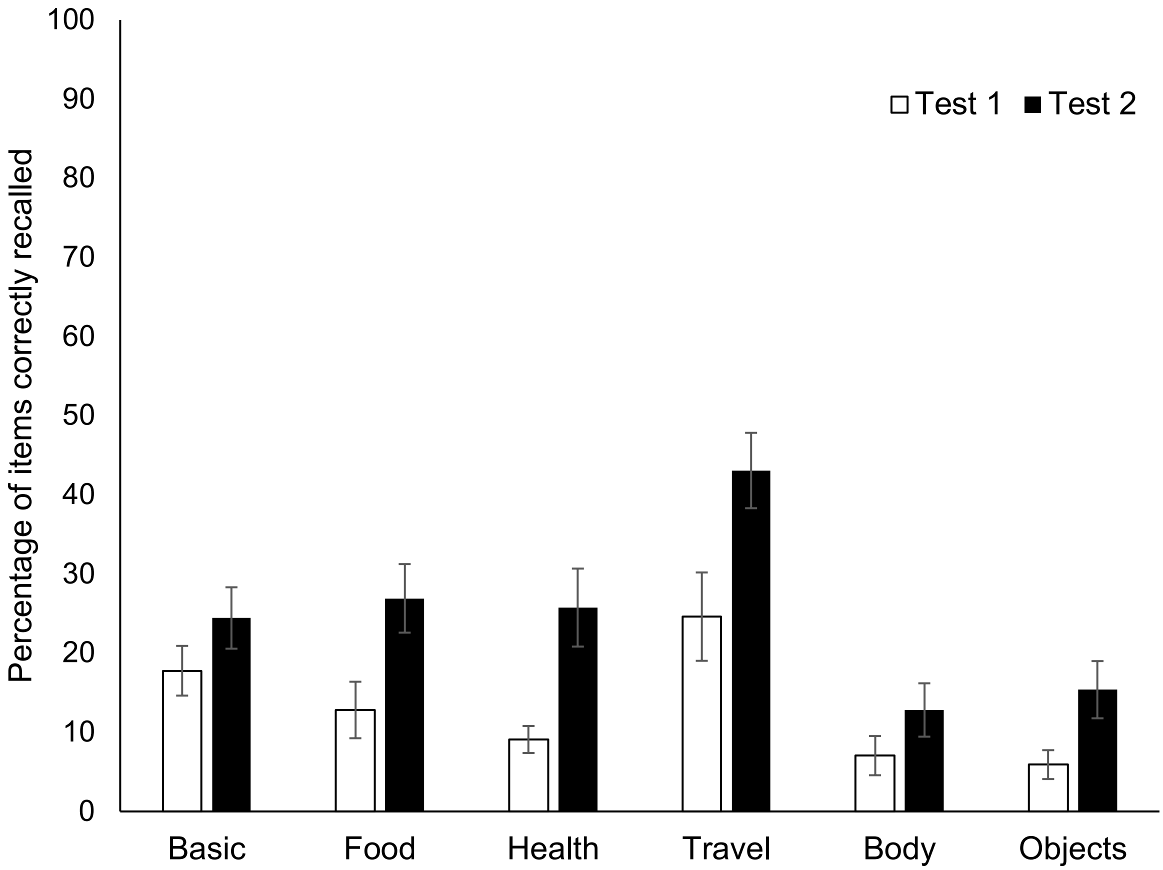

Figure 2.9. Older adults' cued recall performance by category across two tests (in Experiment 5). Error bars represent standard error of the mean.

To examine differences between younger and older adults' cued recall accuracy across the task and across different categories, we conducted a 2(age group: younger vs older) x 2(test: 1 vs 2) x 2(category: important to learn, unimportant to learn) mixed analysis of variance (ANOVA). The category variable was analyzed with two levels (rather than six) to ensure that there were an equal number of data points in each level; that is, each person studied the two "unimportant" categories (body parts and common objects) and two of the "important" categories (e.g., health-related words and travel-related words) per list. No participants studied all of the "important" categories, but the subset they did study were averaged to create one score per participant per list to compare with the score they received per list for the "unimportant" items. This test revealed no three-way interaction, $F(1, 50) = 0.95$, $p = .34$, $\eta^2 = .02$, no two-way interaction between list and category, $F(1, 50) = 1.17$, $p = .28$, $\eta^2 = .02$, and no two-way interaction between category and age group, $F(1, 50) = 2.07$, $p = .16$, $\eta^2 = .02$. There was, however, a significant two-way interaction between list and age group, $F(1, 50) = 40.27$, $p <.001$, $\eta^2 = .15$, in addition to a main effect of list, $F(1, 50) = 172.37$, $p < .001$, $\eta^2 = .66$ and a main effect of age, $F(1, 50) = 40.42$, $p < .001$, $\eta^2 = .45$. To decompose the two-way interaction between list and age group, we conducted post-hoc *t*-tests to compare younger and older adults' performance on each list. On List 1, younger adults ($M = 32.31$, $SD = 20.36$) outperformed older adults ($M = 11.39$, $SD = 9.87$), $t(50) = 4.69$, $p < .001$; on List 2, younger adults ($M = 62.50$, $SD = 24.24$) outperformed older adults ($M = 21.94$, $SD = 15.42$) to a greater extent, $t(50) = 7.20$, $p < .001$.

There was also a significant main effect of category, $F(1, 50) = 38.68$, $p < .001$, $\eta^2 = .43$ such that overall, participants remembered the items in the categories that were "important" to learn for a foreign trip (i.e., food, health, travel, and basic communication words; $M = 37.32$, $SD = 27.55$) more accurately than they did the words that were "unimportant" to learn for a foreign trip (i.e., body parts and common objects; $M = 26.69$, $SD = 27.56$).

Initial importance ratings were also compared among categories and between age groups, to determine if the categories of words chosen by the experimenters to be important to learn were actually rated as such (see Figure 2.10). A 2 (age group) x 4 (category: important to learn, unimportant to learn) mixed-factorial ANOVA was conducted on these responses to assess any differences in importance ratings. This test revealed no two-way interaction between category and age group, $F(1, 50) = 1.31$, $p = . 26$, $\eta^2 = .03$, no main effect of age, $F(1,50) = 0.02$, $p = .88$,

$\eta^2 < .001$, and, somewhat surprisingly, no main effect of category, $F(1, 50) = 0.10$, $p = .75$, $\eta^2 < .01$.

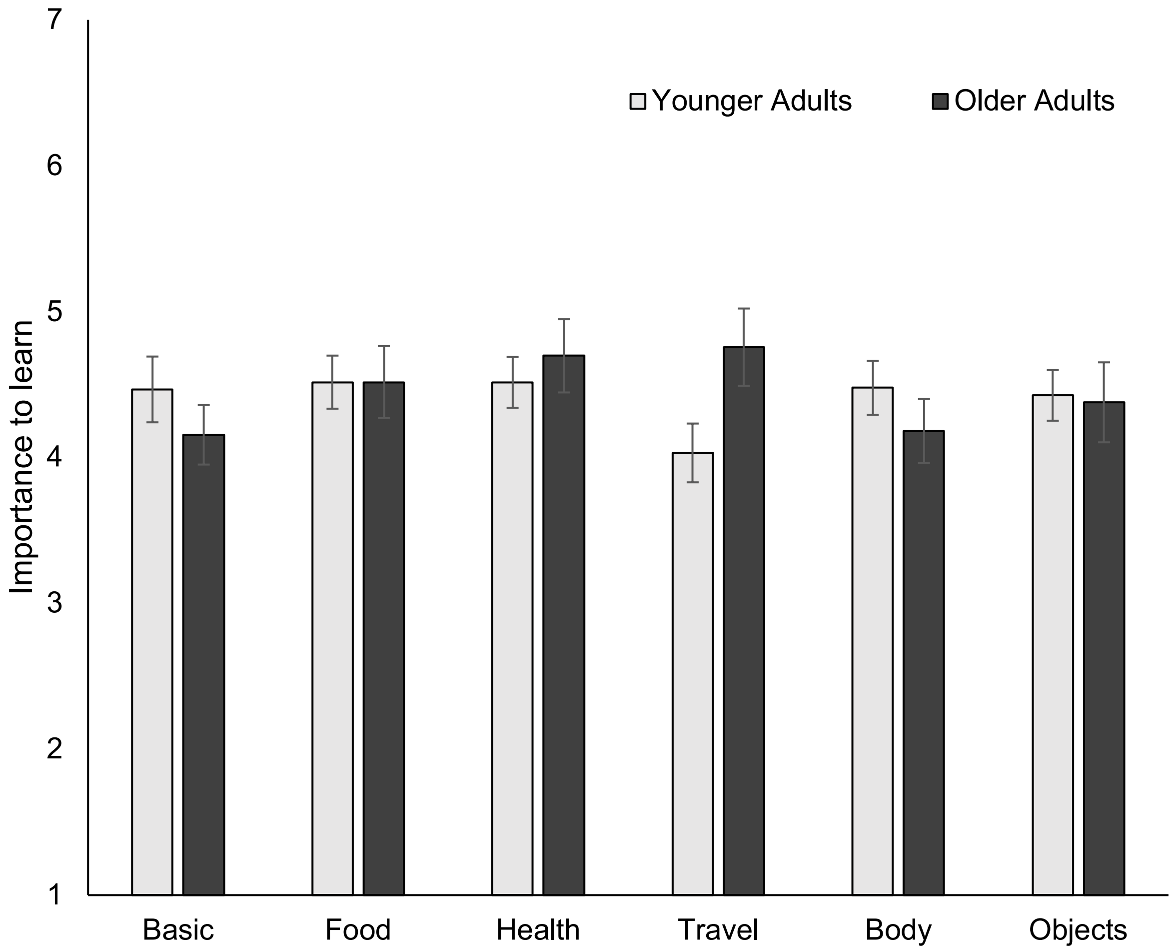

Figure 2.10. Younger and older adults' ratings (in Experiment 5) of how important it would be to learn the Swahili translation of each English word, separated by category. Error bars represent standard error of the mean.

Importance ratings were correlated with accuracy scores to determine whether the ratings of the words differed by category for either age group. As in Experiment 4, participants had not yet seen the Swahili translation when they made their importance ratings, so they were not likely to know how difficult it would be to learn the Swahili translation for each English word. Correlations among younger adults' accuracy scores and importance ratings for the unimportant words were not statistically significant, Spearman's rho = .01, $p = .96$, neither were they for the important words, $r_s = -.20$, $p = .33$. Similarly for older adults, there were not statistically significant correlations between accuracy scores and importance ratings for the unimportant words, $r_s = -.10$, $p = .64$, nor for the important words, $r_s = -.15$, $p = .46$.

Discussion

In Experiment 5, we sought to create a more distinct value structure (i.e., a larger contrast between foreign language words that a traveler would seek to learn for a trip versus words that they would not seek to learn), while ensuring that the lower-value items were frequently-used words that a student who is new to the language may learn. Participants learned two categories of words that were thought to be important to learn on a trip, based on ratings in Experiment 4 (e.g., basic communication words such as "please" and the travel-related words such as "money"), and two categories of words that are common and concrete but are less likely to be needed on a foreign trip (e.g., body parts such as "arm" and common objects such as "pen"). Of course people may still need to use the items in the less important category on their trip (such as when visiting a doctor for a broken arm or requesting to borrow a writing utensil), so we also asked participants for their own ratings of the importance of learning the Swahili translations of the English words before they began the learning phase of the task.

Though their pre-task ratings did not differ between the important and important categories, and those ratings did not correlate with their recall performance, participants' memory performance was affected by the category of the words, such words that were considered less important to learn (by the experimenter) were recalled less accurately than those in the more-important-to-learn category. That is, memory performance was sensitive to value, but participants' ratings were not. This difference between participants' ratings and their actual memory performance is an interesting one. It may be that before the participants begin the study phase, they see each word as fairly important to learn, as each one is a common word that may be used in some situations. However, when participants are faced with the difficult task of learning 24 words in a foreign language, it is not as easy to learn each word, and they recognize that they must apply a strategy.

To assess a potential explanation that recall was driven by the length of the target or cue word, we conducted correlations between recall performance and length of the target and cue words for each age group. Younger adults' recall performance was not correlated with the length of either the Swahili (cue) word or the English (target) word (Swahili words $r_{pb} = -.03$, $p = .49$, for English words $r_{pb} = .04$, $p = .29$). Older adults' recall performance was not correlated with the length of the Swahili word ($r_{pb} = .03$, $p = .27$), but there was a (weak) statistically significant correlation between the length of the English word and the accuracy with which older adults recalled that word ($r_{pb} = 0.07$, $p = .01$).

Participants may have directed their attention to the words that were actually most important to know for their trip, leading to more accurate memory for those items. Older adults' recall performance was overall less accurate than younger adults', especially on the second test, suggesting that older adults did not benefit as much as younger adults did from the opportunity to complete another study-test cycle.

General Discussion

Taken together, Experiments 4 and 5 suggest that participants see many words as equally important to remember when their task is simply to rate their importance. That is, when the stakes or difficulty of the task are low or unknown (they do not need to apply memory strategies to do well on a test, for example; Hargis & Castel, 2017), all words were considered fairly important, as they might be helpful to know on a trip. However, when participants completed the memory task in Experiment 5 (which had a more distinct value structure than Experiment 4), participants learned that they could not remember everything, even if it seemed important during the rating portion of the task. Perhaps this awareness of limited memory capacity led participants to devote attention and resources to the more important words (e.g., Castel et al., 2002), which then led to more accurate recall of those words that were in the "more important" category (e.g., "doctor") compared to the "less important" category (e.g., "desk").

To further investigate potential memory differences among the categories for different age groups, an additional group of 26 younger adults rated the stimuli on the wordlikeness of each Swahili word (ranging from "not like a word at all" to "very like a word", adapted from Nelson & Dunlosky, 1994), and how difficult it would be to learn the English translation of the word (ranging from "not difficult to learn at all" to "very difficult to learn"). The average ratings for each word are presented in Table 2.3.

In Figures 2.11 and 2.12, it appears that the words in the food-related category are rated differently than the words in the other categories, both in wordlikeness and in difficulty to learn. We conducted a one-way ANOVA to assess whether there were differences in ratings of wordlikeness across categories, which revealed a main effect of category, $F(5, 105) = 12.61$, $p < .001$, $\eta^2 = .38$. We conducted a series of *t*-tests to determine where differences among categories lie. Six comparisons were significant after Bonferroni correction for multiple comparisons. Food-related words ($M = 4.61$, $SD = 1.02$) were rated as more like words than basic communication words ($M = 4.12$, $SD = 0.91$), $t(21) = 4.95$, $p < .001$, more like words than travel-related words ($M = 3.52$, $SD = 0.89$), $t(21) = 7.50$, $p < .001$, more like words than health-related words ($M = 3.84$, $SD = 0.84$), $t(21) = 4.22$, $p < .001$, more like words than object words ($M = 4.00$, $SD = 1.07$), $t(21) = 5.70$, $p < .001$, and more like words than body part words ($M = 3.83$, $SD = 0.94$), $t(21) = 6.47$, $p < .001$. Basic communication words were also rated as more like words than travel-related words, $t(21) = 5.64$, $p < .001$, all other *p*s > .003.

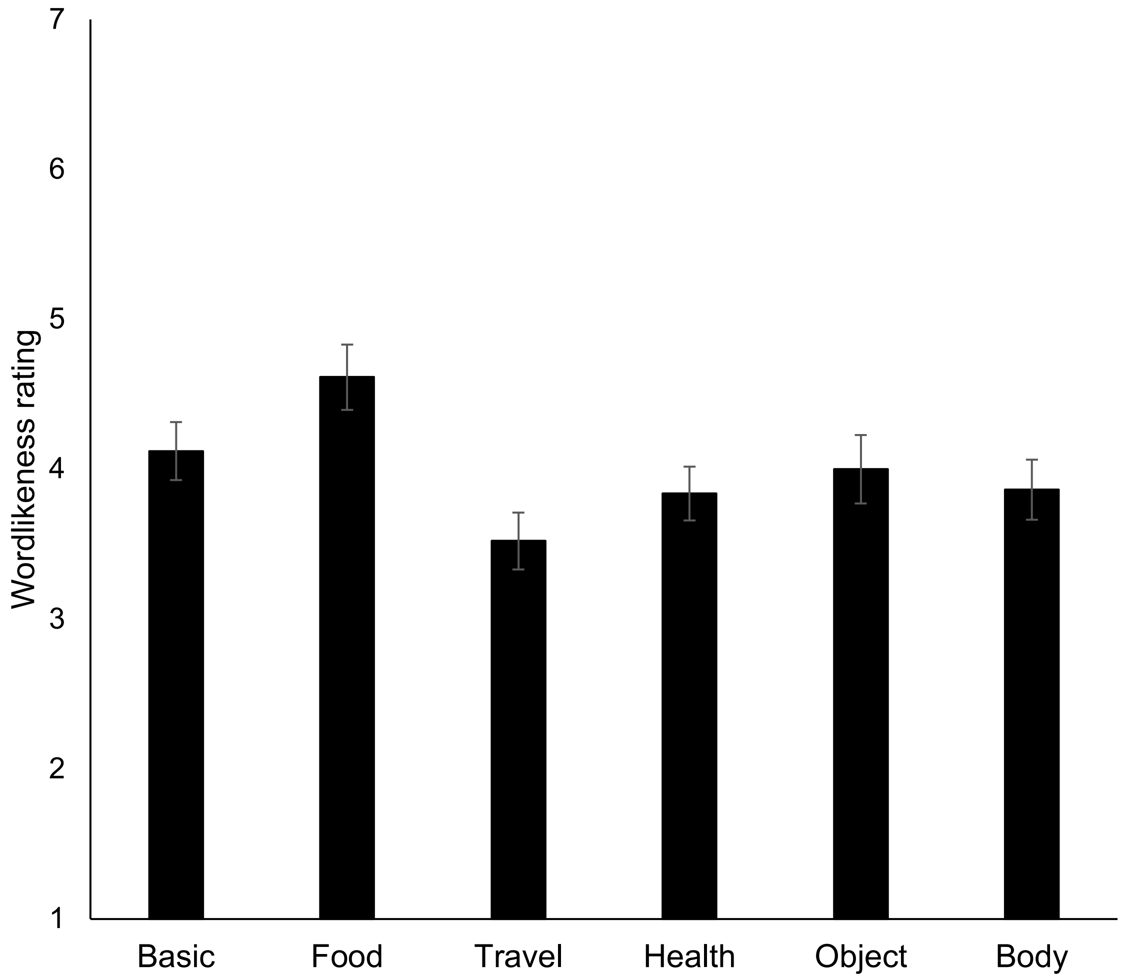

Figure 2.11. New participants' ratings of how much each Swahili item in Experiment 5 was like a word, separated by category. Error bars represent standard error of the mean.

We also conducted a one-way ANOVA to assess whether there were differences of ratings of difficulty to learn across categories, which also revealed a main effect of category, $F(5, 105) = 14.75$, $p < .001$, $\eta^2 = .41$, see Figure 2.12. Five comparisons were significant after Bonferroni correction for multiple comparisons. Food-related words ($M = 3.43$, $SD = 0.88$) were rated as easier to learn than basic communication words ($M = 4.02$, $SD = 0.83$), $t(21) = 4.73$, $p < .001$, easier to learn than travel-related words ($M = 4.41$, $SD = 0.88$), $t(21) = 7.37$, $p < .001$, easier to learn than object words ($M = 4.30$, $SD = 0.79$), $t(21) = 6.72$, $p < .001$, and easier to learn than body part words ($M = 4.07$, $SD = 0.87$), $t(21) = 5.12$, $p < .001$. (The only category that did not significantly differ from food-related words was health-related words ($M = 3.93$, $SD = 0.72$), $t(21) = 3.05$, $p = .01$, the significance of which did not survive alpha correction). Health-related words were also rated as easier to learn than travel-related words, $t(21) = 3.47$, $p = .002$; all other ps > .003.

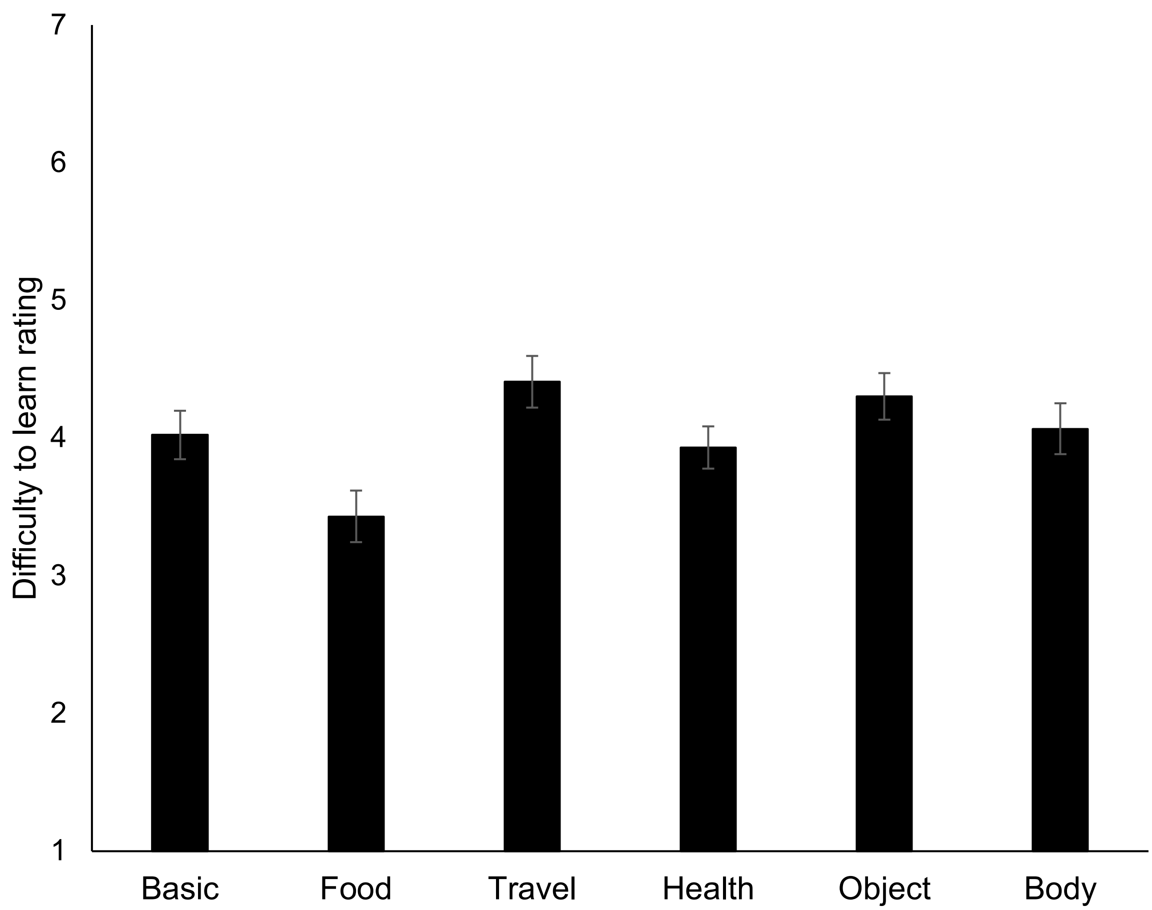

Figure 2.12. New participants' ratings of how difficult it would be to learn the translation for each Swahili word in Experiment 5, separated by category. Error bars represent standard error of the mean.

To determine whether the length of the Swahili words differed by category, we conducted a one-way ANOVA, which revealed no main effect of category, $F(5, 30) = 1.20$, $p = .33$, $\eta^2 = .17$ (though, numerically, there do seem to be differences when comparing the lengths of the food [$M = 5.50$, S$D = 1.22$] and body part [$M = 5.67$, $SD = 0.62$] words with, for example, the lengths of the object [$M = 7.33$, $SD = 1.51$] and travel-related [$M = 7.20$, $SD = 2.61$] words). Future research may examine what is special about food-related words – that is, what causes them to be rated as more like words and less difficult to learn than other categories; regardless, the cued recall performance for food-related words was not different than other categories in the current experiments (see Figures 2.5, 2.6, 2.8 and 2.9).

In sum, the current studies provide further evidence that younger and older participants may not truly appreciate how we are motivated to learn until they are in a learning environment. That is, people may think it would be helpful to remember everything they plan to study, only to find, during study and/or test, that their memory capacity is limited and they need to prioritize. Previous work on PAL suggests that the concreteness of cue-target pairs (Paivio, 1965), the imageability of the pairs (Papagno et al., 1991), and the semantic relatedness of the pairs (Arenberg & Robertson-Tchabo, 1977) can affect learning; in the current study, we argue that subjective importance can affect learning as well (even if participants' initial perceptions of what is important do not follow expected patterns).

The current work is in line with previous studies suggesting that older adults perform less accurately than younger adults do on associative memory tasks (Arenberg & Robertson-Tchabo, 1977; Naveh-Benjamin, 2000; Rast & Zimprich, 2009; Service & Craik, 1993; cf. Hargis & Castel, 2017; Hargis & Castel, 2018; Treat & Reese, 1976). Though the goal to learn words for an upcoming trip was at least partially social in nature (Carstensen et al., 1999), older adults' performance was less accurate than younger adults' performance when learning these items. This pattern of performance was not unexpected, given that the current studies used a difficult associative memory task. Future work could investigate how introducing effective study strategies (e.g., Treat & Reese, 1976) could potentially improve older adults' performance on a Swahili PAL task, as well as how the advent of new language-learning technologies (e.g., Duolingo, Memrise, and other smartphone applications) may allow participants to easily prioritize (and, perhaps, offload) which words are most important to know when communicating with others in a foreign country.

Chapter 2 Conclusions

Substantial prior work suggests a general shift in priorities with aging. While younger adults aim to gain new knowledge that will benefit them in future careers, older adults' main goal is to build and maintain relationships with close friends and family. There are interesting areas, however, in which these goals may overlap, such as remembering information about people who one has just met, and are likely (or not likely) to meet again. In Experiments 1 and 2, participants in both age groups learned information about people with whom they would interact in the future with relatively high accuracy, but age-related deficits occurred in recall of information about people with whom the participant would not interact in the future. These findings relate to work that illustrates an awareness among older adults that their future is finite: since time and resources are limited, perhaps it is not important to remember information one definitely will not use in the future. Study 3 examined participants' judgments about their own ability to remember names. The better-than-average effect has been demonstrated in multiple domains of cognitive and social psychology, but Study 3 suggests that participants across the adult lifespan may not commit that bias in their perception of their ability to remember names.

Building upon findings from Experiments 1 and 2, Experiments 4 and 5 were constructed to create a different type of overlap between knowledge-based and socio-emotional goals. The former two Experiments focused on how age and importance affect participants' learning of information *about* others, and the latter two Experiments focused on how age and importance affect participants learning of information they could use *with* others. The backstory told to participants in Experiments 4 and 5 was meant to activate the potential for both social and knowledge-based goals; visiting a foreign country where one does not know the language will almost certainly involve social interaction (e.g., while navigating the streets or enjoying the local cuisine), but there may also be a strong motivation to learn new information (e.g., about local history or art). Utilizing this combination of both social and knowledge-based motivations, Experiments 4 and 5 suggest that while older adults are overall less accurate in learning Swahili-English word pairs than younger adults are, both groups do prioritize information that would be more important for their trip once the value structure is made more obvious (even if their pre-task ratings do not reflect a sensitivity to the words' relative importance). While overall differences in goal pursuit among younger and older adults are well established, motivation and priorities often overlap between younger and older adults, and the dichotomy between knowledge-based and socio-emotional goals is not always absolute. Chapter 2 focused primarily on how we learn in service of social goals and in service of goals that have both social and knowledge-based components. Chapter 3 will investigate how importance and age affect learning goals that are primarily knowledge-based.

Table 2.1

Spearman Correlations: Younger Adults in Study 3

	Age	Ability to get along with others	Capacity for hard work	Leadership ability	Honesty	Historical Memory	Location Memory	Memory for People's names	Memory overall
Age	—	-0.030	-0.116	-0.095	-0.091	-0.001	-0.022	0.036	0.078
Ability to get along with others		—	0.181	0.175	0.300**	-0.122	-0.069	0.345 ***	0.156
Capacity for hard work			—	0.462***	0.301**	0.091	0.158	0.212	0.239 *
Leadership ability				—	0.220*	0.085	0.119	0.099	0.206
Honesty					—	0.062	-0.060	0.041	0.015
Historical Memory						—	0.167	0.095	0.227 *
Location Memory							—	0.126	0.230 *
Memory for People's Names								—	0.260 *
Memory overall									—

Note. * p < .05, ** p < .01, *** p < .001.

Table 2.2

Spearman Correlations: Older Adults in Study 3

	Age	Ability to get along with others	Capacity for hard work	Leadership ability	Honesty	Historical Memory	Location Memory	Memory for People's names	Memory overall
Age	—	0.100	-0.039	-0.115	0.059	0.025	-0.006	-0.039	-0.086
Ability to get along with others		—	0.390 ***	0.340 **	0.380 **	0.225	0.259 *	0.512 ***	0.243
Capacity for hard work			—	0.466 ***	0.288 *	0.208	0.013	0.415 ***	0.516 ***
Leadership ability				—	0.365 **	0.277*	0.370 **	0.449 ***	0.358 **
Honesty					—	0.284*	0.316 **	0.204	0.183
Historical Memory						—	0.355**	0.279 *	0.380 **
Location Memory							—	0.358 **	0.275 *
Memory for People's Names								—	0.498 ***
Memory overall									—

Note. * p < .05, ** p < .01, *** p < .001.

Table 2.3

Words presented to participants in Experiments 4 and 5, including their semantic category, as well as other participants' ratings of each Swahili word's wordlikeness and difficulty to learn.

Swahili (cue)	English (target)	Category	Wordlikeness Rating	Difficulty Rating
asante	thank you	basic	5.64	3.00
chakula	food	food	5.23	3.23
chumba	room	travel	5.41	2.82
dawa	medicine	health	5.14	2.82
dawati	desk	object	5.00	3.50
dharura	emergency	health	2.95	4.86
dririsha	window	object	3.14	4.91
fedha	money	travel	4.45	3.73
hapana	no	basic	5.73	2.77
homa	fever	health	6.23	2.05
hujambo	hello	basic	4.05	4.09
jicho	eye	body	4.68	3.64
kalamu	pen	object	4.86	3.14
kichwa	head	body	4.32	3.64
kikombe	cup	object	4.77	3.68
kinywa	mouth	body	3.71	4.59
kitambulisho	identification	travel	3.32	5.55
kwaheri	goodbye	basic	3.27	4.36
maji	water	food	5.14	2.86
matunda	fruit	food	5.27	3.32
mboga	vegetables	food	2.73	4.68
mgahawa	restaurant	travel	2.36	4.95
mganga	doctor	health	2.86	4.36
mkono	arm	body	3.27	4.18
muuguzi	nurse	health	2.68	4.86
mwenyekiti	chair	object	2.00	6.05
ndege	plane	travel	2.09	5.18
ndio	yes	basic	2.59	4.77
nyama	meat	food	4.23	3.50
nyewle	hair	body	1.95	5.27
pombe	beer	food	5.09	3.00
shingo	neck	body	5.18	3.09

suruali	pants	object	4.23	4.55
tafadhali	please	basic	3.41	5.14
ubalozi	embassy	travel	3.48	4.23
wagonjwa	sick	health	3.10	4.64

CHAPTER 3: YOUNGER AND OLDER ADULTS' MEMORY FOR IMPORTANT HEALTH-RELATED INFOMRATION

Portions of the following introductory comments, description of Experiments 1 and 2, and conclusion are taken directly from Hargis & Castel (2018)

While socio-emotional goal pursuit is a notable shift that occurs in many contexts, it is not all-encompassing for older adults. Many older adults seek to learn into and after retirement – if not in service of their careers, perhaps in relation to their hobbies of birdwatching, crafting, or travelling, or even for the sake of learning itself (Wolfgang & Dowling, 1981). The assumption that younger adults pursue only knowledge and older adults pursue only social connection is an overly vague one, which Carstensen et al. (1999) acknowledge. Just because older adults are not learning in a formal education setting (though many are, see Bye, Pushkar, & Conway, 2007), does not mean they cease to acquire knowledge. Similarly, younger adults may strive to acquire knowledge that can benefit them in the future, but also to build and maintain close relationships.

There are notable instances in which older adults are motivated by both social and informational purposes. For example, if one is learning about a new diagnosis from a physician, the patient can be motivated to remember the information for at least two purposes: to adhere to the physician's recommendations, of course, and also to share that information with a friend or loved one who is concerned about the patient or who can assist the patient in adhering to the instructions. Some of the information gathered in this context may be more important to remember (e.g., what foods to avoid while taking a newly-prescribed medication) and other information may be less important to remember (e.g., what color the doctor's eyes were), and participants are often sensitive to differences in relative importance, even in a lab setting (e.g., Castel et al., 2002). Individuals across the lifespan are often highly motivated to remember information about their own health or diagnoses, but this information is not inherently social in nature (though there are certainly components that involve social interaction, see Beisecker & Beisecker, 1990; Maynard & Heritage, 2005; Ryan, Hummert, & Boich, 1995).

Chapter 3 is devoted to exploring how older adults are motivated to learn health-related information that is not explicitly social. Experiments 3 and 4 do have components of social communication, but the focus is expanded to include learning information for the purpose of increasing one's own knowledge about a given topic. These instances are not intended to be merely exceptions to the general rule of primarily social motivation in aging, but notable learning opportunities that may reflect experiences in individuals' daily lives. Therefore, the following Chapter will examine how younger and older adults acquire knowledge about relatively practical information of varying importance in contexts requiring participants to bind information together in memory and, under certain circumstances, face interference and confusability between items.

Experiment 1

When individuals try to adhere to a medication regimen, important information can be overlooked, often due to interference and limited memory capacity. More than half of older adults take five or more medications and/or supplements on a regular basis (Qato et al., 2008), while many younger adults take medications for both medical and non-medical reasons (e.g., as a stimulant, White, Becker-Blease, & Grace-Bishop, 2006), and often without considering how other medications, foods, or drinks may interact with those substances. Thus, remembering information about which substances are safe or dangerous to consume together could have important implications for overall health. Remembering medical information often requires making an association between two or more items; for example, what medication(s) should not be taken concurrently with another medication. The associative deficit hypothesis suggests that the association of items in memory is detrimentally affected in older age (Naveh-Benjamin, 2000). This deficit is pervasive and present in various memory recall tasks, including remembering word-nonword pairs (Naveh-Benjamin, 2000), pairs of pictures (Naveh-Benjamin, Hussain, Guez, & Bar-On, 2003), and name-face pairs (Naveh-Benjamin, Guez, Kilb, & Reedy, 2004; though this can be affected by the value of the information and reduced with repeated testing, see Hargis & Castel, 2017).

However, there are instances in which age-related differences in memory are not present, including tasks examining value-directed remembering, or the strategic focus on important items in light of memory capacity limitations (Castel, 2008). Previous studies examining how value affects memory have utilized words paired with random point values (e.g., Castel, Benjamin, Craik, & Watkins, 2002; Castel, Murayama, Friedman, McGillivray, & Link, 2013). These studies provide evidence that while older adults' overall memory performance is less accurate than younger adults', older adults are still able to remember what is valuable, especially with task experience. However, value does not always eliminate age-related recall differences in associated information, as an age-related memory deficit has been shown for recall of high-value word pairs (Ariel, Price, & Hertzog, 2015). Younger and older adults recognized that high value pairs are important (as shown by their preference to study high-value over low-value items), but older adults did not recall the pairs as accurately as younger adults did. The interplay between aging, memory selectivity, and associative memory is examined in the current study using an associative recognition paradigm and novel medication stimuli.

A value-based mechanism such as health risk could provide a structure in which older adults can overcome associative memory deficits, at least for the most important information.

Middlebrooks, McGillivray, Murayama, and Castel (2015) presented younger and older participants with a list of allergens (e.g., peanut) that varied in severity. Younger participants recalled more allergens initially, but age differences in recall of the most severe items were no longer apparent after participants gained some experience with the task. Similarly, older adults have been shown to accurately remember important medication side effects if the effects are framed in terms of detecting dangerous outcomes (Friedman, McGillivray, Murayama, & Castel, 2015). Participants studied and rated the unpleasantness of a group of side effects (each of which had been previously classified as mild, moderate, or severe), and were then asked to recall as many side effects as they could in a free recall paradigm. There were no differences in younger and older adults' recall of these items, but the groups were affected by the level of severity differently, such that older adults remembered more severe side effects (e.g., stroke) than mild side effects (e.g., itching). While these studies (Friedman et al., 2015; Middlebrooks et al., 2016) suggest that older adults can prioritize valuable medical information for item recall, this has not been investigated with the added task demands of associating multiple items in memory.

The use of prior knowledge through schematic support can also benefit older adults in memory tasks (e.g., Castel, 2005); however, this benefit is not present in all domains (Morrow, Menard, Stine-Morrow, Teller, & Bryant, 2001). Older adults' memory for medication side effects, for example, is thought to benefit from schematic support (Friedman et al., 2015), as many older adults have experienced taking medications throughout their lives (Qato et al., 2008). Additionally, being able to refer a to-be-remembered item to oneself benefits older adults' recall (Gutchess, Kensinger, Yoon, & Schacter, 2007), which may occur in healthcare situations if one intentionally connects information found online or provided by a physician to one's own life or experiences. While personal connections to the information and schematic support may lead to older adults' improved memory accuracy in some situations (see Umanath & Marsh, 2014), memory for medication information that is familiar but not factually correct could in fact impair memory if it contradicts older adults' schemas and beliefs (e.g., Rice & Okun, 1994), suggesting that schematic support is not universally beneficial.

When given multiple study-test trials, participants often learn from their prior task experience and performance improves as the task goes on. This "testing effect" is well-established among younger adult participants (e.g., Allen, Mahler, & Estes, 1969; Carrier & Pashler, 1992). However, the literature examining older adults' memory for associative information across several study-test trials is mixed. For example, Overman and Becker (2009) found that re-studying face-word pairs did not improve older adults' recall of those pairs, while findings by Kilb and Naveh-Benjamin (2011) suggest that older adults can benefit from repeated studying (as can younger adults) when given pairs of pictures to remember. There is also evidence that older adults benefit differently from prior task success than do younger adults (Geraci & Miller, 2013; Geraci, Hughes, Miller, & De Forrest, 2016). The current study utilizes multiple study-test cycles to assess how associative memory performance changes with task experience, both when binding items (Experiment 1) and when binding under conditions that may create memory interference (Experiment 2).

Due to their associative nature, medication interactions may be difficult for older adults to remember. This could have serious implications for health if one forgets that grapefruit, for example, should not be eaten while taking medication for high cholesterol. The current study examines how younger and older adults remember associative medication information of varying levels of severity across several study-test trials. If older adults engage in selective strategies during encoding, they are likely to remember the high-value (important) items as accurately as younger adults, especially with task experience, but their overall performance may be less accurate due to deficits in associating information in memory.

Experiment 1 was conducted to examine how younger and older adults' associative recognition of medication interactions are influenced by the importance (in terms of health outcomes) of those associated items. Younger and older participants viewed a series of interactions that were assigned to one of three outcomes (severe, mild, or no interaction) and were tested via associative recognition for a total of three study-test cycles.

Method

Participants

Younger adults (n = 26) were undergraduate students at University of California, Los Angeles and were recruited through the Psychology Department subject pool (M_{age} = 20.81, SD = 1.94), 18 were female and 1 did not report gender. Older adults (n = 26) were recruited from the Los Angeles community (M_{age} = 68.72, SD = 5.50), 15 were female. Most older adults had obtained undergraduate (42%) or graduate (42%) degrees. This research was approved by the UCLA Institutional Review Board.

Materials and Procedure

Participants were asked to imagine that their doctor was describing a series of interactions between medications. They began by reading a short explanation of what medication interactions are, and that they can result in health outcomes that vary in severity. Three levels of severity were outlined to the participant: no interaction (no effect on health), mild interaction (slight health effects), and severe interaction (life-threatening health effects). Participants were then presented with 15 unique pairs of stimuli (five in each severity category) in randomized order. There were three pairs of each of the following combinations: real medication - real medication, fictitious medication - fictitious medication, real medication - fictitious medication, real medication - consumable substance (e.g., bananas, licorice), and fictitious medication - consumable substance. The average length of the medications was 7.90 letters (*SD* = 1.45), while the average length of the food words was 9.00 letters (*SD* = 2.68).

Each medication was displayed on a computer screen as the label on an orange prescription bottle, and each substance was displayed as a photograph with the name of the item under (see Figure 4.1a and 4.1b for example study and test trials). The fictitious medications were chosen to resemble actual medications without being highly familiar to the participants (e.g., Dypraxa, Clavosec), thus reducing the possibility of using schematic support to recall the fictitious items. If there was a mild or severe outcome that would occur when consuming the two substances, it was presented with an example, e.g., “Severe (stroke)”. Participants were given 7s to study each pair, with the instruction that they were to remember as much as they could about each interaction. The items in each pair were randomly assigned to each other, as were the outcomes to each pair, and these were held constant throughout the study-test trials for each participant. At test, participants were presented with each pair of medications and asked to choose the severity of the outcome that would occur if they were to be taken together. Participants were given the answer choices “severe,” “mild,” or “no interaction” and asked to choose one. This study-test procedure was completed for two additional cycles with the same information on each in newly randomized orders.

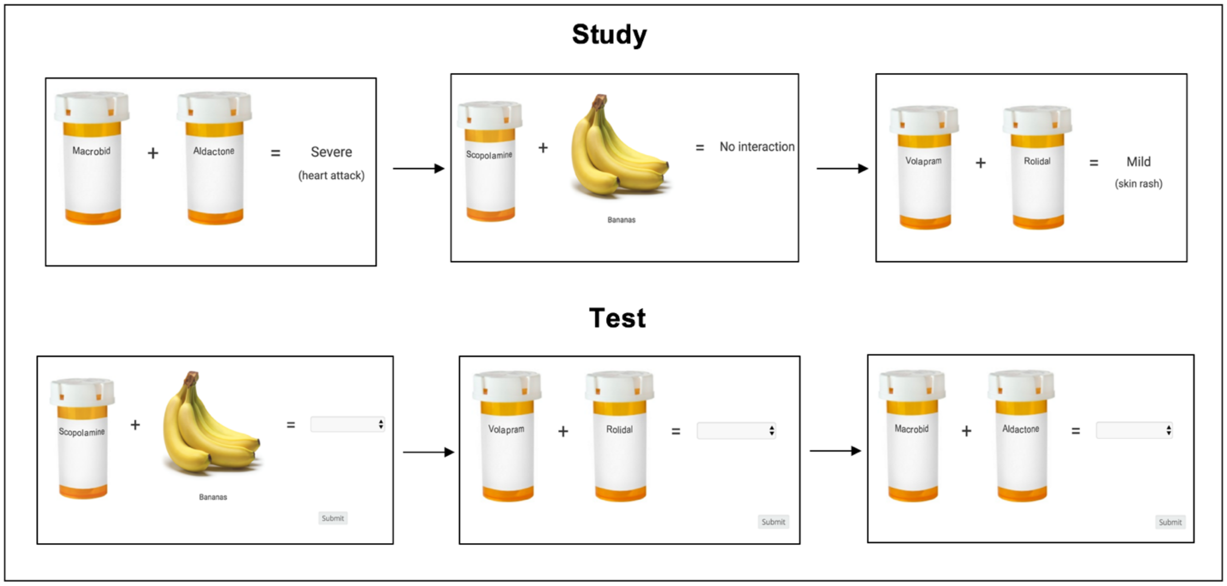

Figure 3.1. Three example study and test trials from Experiment 1. Participants were given 7s to study each of 15 pairs and were later tested on the outcome.

Results

The memory accuracy of both age groups across the task is presented in Figure 3.2. To determine whether age and severity affected recognition accuracy of medication interactions, a 2(Age group: younger or older) X 3(Severity: no interaction, mild interaction, severe interaction) X 3(Test) mixed-factorial analysis of variance (ANOVA) was conducted. There was no main effect of age on recall, $F < 1$, $p = .80$, $\eta^2 < .01$. There was a significant main effect of severity, $F(2,100) = 7.23$, $p < .01$, $\eta^2 = .12$. Follow up *t*-tests using Bonferroni corrections indicated that recognition accuracy of severe interactions ($M = 0.78$, $SD = 0.16$) was more accurate than recognition accuracy of mild interactions ($M = 0.69$, $SD = 0.15$), $t(51) = 3.76$, $p < .001$, and no interactions ($M = 0.69$, $SD = 0.17$), $t(51) = 3.87$, $p < .001$, but there was no difference between recognition accuracy of no interactions and mild interactions, $t(51) = .21$, $p = 1.00$. A marginally significant two-way interaction between age and severity was also revealed, $F(2, 100) = 3.09$, p

= .05, η^2 = .05. Though this interaction was not significant at an alpha-level of .05, we conducted follow-up tests to further examine potentially interesting patterns. These ANOVAs revealed that younger adults' recognition accuracy was not significantly affected by severity, $F(2,50) = 2.02$, $p = .14$, $\eta^2 = .08$. Older adults' recognition accuracy, however, was affected by severity, $F(2,50) = 6.88$, $p < .01$, $\eta^2 = .22$, such that interactions associated with the lowest level of severity (M = 0.69, SD = 0.20) were remembered less accurately than those associated with the highest level of severity (M = 0.80 , SD = 0.14), $t(25) = 3.42$, $p < .01$. Interactions associated with a moderate level of severity (M = 0.66, SD = 0.15) were also remembered less accurately than those with the highest level of severity, $t(25) = 4.61$, $p < .001$. There was no difference in recognition accuracy of mild interaction and no interaction pairs, $t(25) = 0.81$, $p = 1.00$.

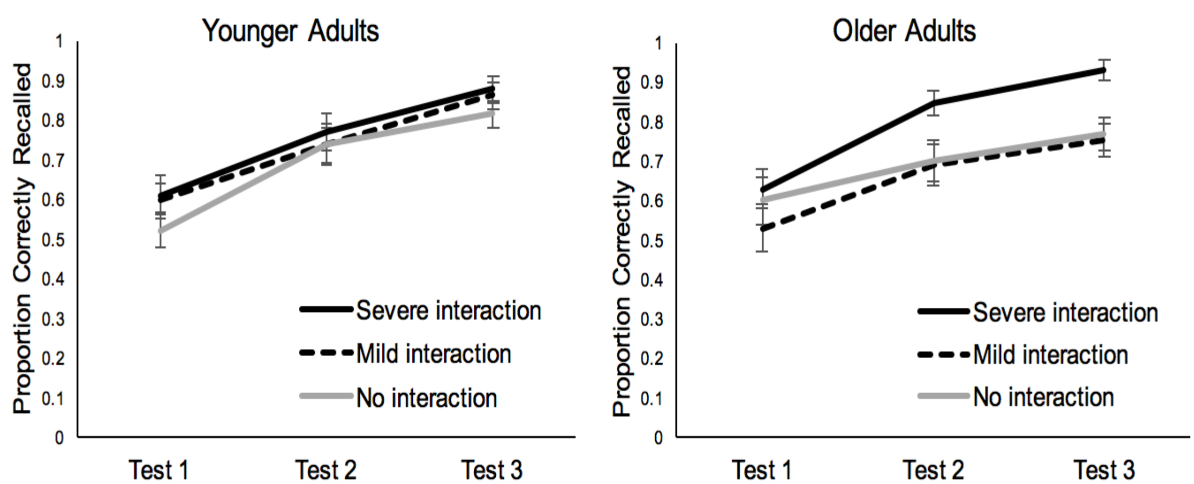

Figure 3.2. Performance on a series of three cued-recall tests in Experiment 1 by younger adults and older adults. Error bars represent standard error of the mean.

There was a main effect of test, $F(2,100) = 72.03$, $p < .001$, $\eta^2 = .59$, such that overall performance on Test 2 (M = 0.75, SD = 0.15) was more accurate than Test 1 (M = 0.58, SD =

0.17), $t(51) = 4.77$, $p < .001$, and performance on Test 3 ($M = 0.83$, $SD = 0.13$) was more accurate than on Test 2, $t(51) = 2.93$, $p = .01$. No other effects were significant, $p > .45$. Additional tests were conducted to determine whether the presence of a food or drink item in an interaction led to more accurate recall of that interaction. A 2(Age group) X 2(Consumable substances or only medications) revealed that items containing food or drink ($M = 0.87$, $SD = 0.10$) were recognized more accurately than those that contained only medications, ($M = 0.62$, $SD = 0.16$), $F(50) = 161.24$, $p < .001$, $\eta^2 = .76$. This did not interact with age, $F(1,50) = 1.63$, p = .21, $\eta^2 < .01$. Finally, the associative recognition of real medications and fictitious medications was compared. A 2(Age group) X 2(real or fictitious) ANOVA revealed no differences in recognition, $F(1, 50) = 1.49$, $p = .23$, $\eta^2 = .23$; this also did not interact with age, $F(1, 50) = 1.49$, $p = .23$, $\eta^2 = .03$.

Both age groups recognized the "severe" outcome with relatively high accuracy. We sought to determine whether there was a bias in either age group's responses toward choosing "severe" more often than other options, perhaps as a guess if they were unsure of the outcome. Throughout the task, a total of 15 "severe" pairs were shown. Therefore, we compared the total number of times a participant chose "severe" in all three tests to 15. Neither age group deviated significantly from this number: younger adults chose "severe" an average of 14.69 times ($SD = 1.78$), and older adults chose "severe" an average of 15.35 times ($SD = 2.71$). There were no differences between the amount of "severe" responses given by younger and older adults, $t(50) = 1.03$, $p = .31$.

Discussion

Given a series of medication interactions that varied in the severity of their outcomes on health, only older adults' recognition accuracy was affected by that severity. Younger adults, who are often more accurate than older adults in remembering associative information overall (e.g., Naveh-Benjamin, 2000; Naveh-Benjamin, et al., 2003), were not sensitive to information importance (i.e., the severity of the health outcome). This is perhaps because performance was already quite accurate, so the use of a value-based selectivity strategy was not necessary. Older adults, however, remembered severe health outcomes more accurately than the outcomes that were not deemed life-threatening, but there was no evidence of a bias towards "severe" in their responses. Older and younger adults remembered high-value associations with equivalent accuracy (cf. Ariel et al., 2015), and there were no age-related differences in overall performance, in contrast with previous literature showing an age-related associative deficit in memory (Naveh-Benjamin, 2000).

Pairs of items that included a food or drink item (e.g., grapefruit) in addition to a medication were remembered more accurately, possibly due to the distinctiveness of these items (Hunt & Worthen, 2006) as compared to medication-medication pairs. Fictitious but realistic medications were remembered as accurately as real medications. Perhaps participants did not recognize the real medications and therefore did not remember them any differently than fictitious medications. On the other hand, even if they did recognize real medications, perhaps participants did not have the time, inclination, or familiarity to use schematic support or prior experience to remember real items more accurately than items they would never have encountered before.

Overall, participants in Experiment 1 performed well on the task. It is possible that participants could have performed well by only remembering that one medication was associated with a certain outcome (e.g., knowing that the drug Namenda is associated with a mild interaction) and the pair of medication items did not therefore need to be encoded concurrently with its outcome to answer correctly on the final test. Also, it is not always the case that one medication interacts with only one other substance; in fact, one medication can interact in varying ways with a set of other medications. These types of associations in which one item is associated with several other items can cause more interference in memory, a process known as the fan effect (Anderson, 1974; Anderson & Reder, 1999). The fan effect paradigm has been used to examine how younger and older adults remember a series of items associated to another particular item (Gerard, Zacks, Hasher, & Radvansky, 1991). The larger the "fan," or the more items that are associated with that item, the more difficult the task usually is, especially for older adults. If one item is associated with several others, older adults are often less accurate than younger adults in remembering those items.

Experiment 2

In Experiment 1, younger and older adults recognized the severity associated with a pair of medications with equivalent accuracy. Experiment 2 was conducted to examine the role of interference in memory for medication information among younger and older adults. Participants viewed a set of medication interactions in which each medication interacted with five other medications. Memory was assessed with multiple study-test trials. If the connections between medications interfere with each other in memory, older adults are expected to be differentially affected by this. While they still may engage in value-directed remembering, the level of interference caused by binding one item to five other items (in addition to the task requirements of associating multiple items) may lead to age-related differences in overall performance.

Method

Participants

Younger adults (n = 26) were undergraduate students at University of California, Los Angeles and were recruited through the Psychology Department subject pool, M_{age} = 20.19, SD = 1.06, 15 were female. Older adults (n = 26) were recruited from the Los Angeles community, M_{age} = 68.42, SD = 6.91, 15 were female. Most older adults had obtained undergraduate (50%) or graduate (34%) degrees. This research was approved by the UCLA Institutional Review Board.

Materials and Procedure

Instructions given to participants were identical to Experiment 1. Unlike in Experiment 1, participants in Experiment 2 were presented with only six unique medications (no food or drinks), which each appeared in five different interactions for a total of 15 items. For example, Dypraxa : Cordarone could lead to a mild interaction, Dypraxa : Doloxan to a severe interaction, and Cordarone: Doloxan to no interaction. The assignment of severity to each interaction was randomized for each participant. As in Experiment 1, the medications were presented on a computer screen as orange prescription bottles with only the name of the medication on the label. Participants were given 7s to study each pair, and were asked to choose the severity of the interaction that would occur given the choices "severe," "mild," or "no interaction" at test. This study-test procedure was completed for two additional cycles with the same information on each study and test in newly randomized order.

Results

The memory accuracy of both age groups across the task is presented in Figure 3.3. To determine whether age and severity affected associative recognition of medication interactions, a 2(Age group: younger or older) X 3(Severity: no interaction, mild interaction, severe interaction) X 3(Test) mixed-factorial analysis of variance (ANOVA) was conducted. There was no main effect of age on accuracy, $F(1,50) = 1.66$, $p = .20$, $\eta^2 = .03$. There was a significant main effect of severity, $F(2,100) = 4.27$, $p = .02$, $\eta^2 = .08$. Follow up t-tests using Bonferroni corrections indicated that associative recognition of severe interactions ($M = 0.53$, $SD = 0.17$) was more accurate than that of mild interactions ($M = 0.46$, $SD = 0.15$), $t(51) = 3.56$, $p = .03$, and no interactions ($M = 0.44$, $SD = 0.17$), $t(51) = 3.14$, $p < .01$, but there were no differences between recognition of no interactions and mild interactions, $t(51) = .65$, $p = 1.00$. Unlike in Experiment 1, there was no significant interaction between age and severity, $F(2, 100) = 2.30$, $p = .11$, $\eta^2 = .04$. There was a significant main effect of test, $F(2, 100) = 12.83$, $p < .001$, $\eta^2 = .20$. Follow up t-tests using Bonferroni corrections indicated that performance on Test 2 ($M = 0.49$, $SD = 0.13$) was more accurate than performance on Test 1, ($M = 0.41$, $SD = 0.14$), $t(51) = 4.05$, $p < .001$ and Test 3 ($M = 0.52$, $SD = 0.17$), was more accurate than Test 1, $t(51) = 4.74$, $p < .001$, but there were no differences on Tests 2 and 3, $t(51) = 1.28$, $p = .61$. No other effects were significant, *p*s > .22. As in Experiment 1, a 2 x 2 ANOVA revealed no differences in recognition accuracy for real and fictitious medications, $F(1, 50) = 0.20$, $p = .66$, $\eta^2 < .01$, this did not interact with age, $F(1, 50) = 3.19$, $p = .08$, $\eta^2 = .06$.

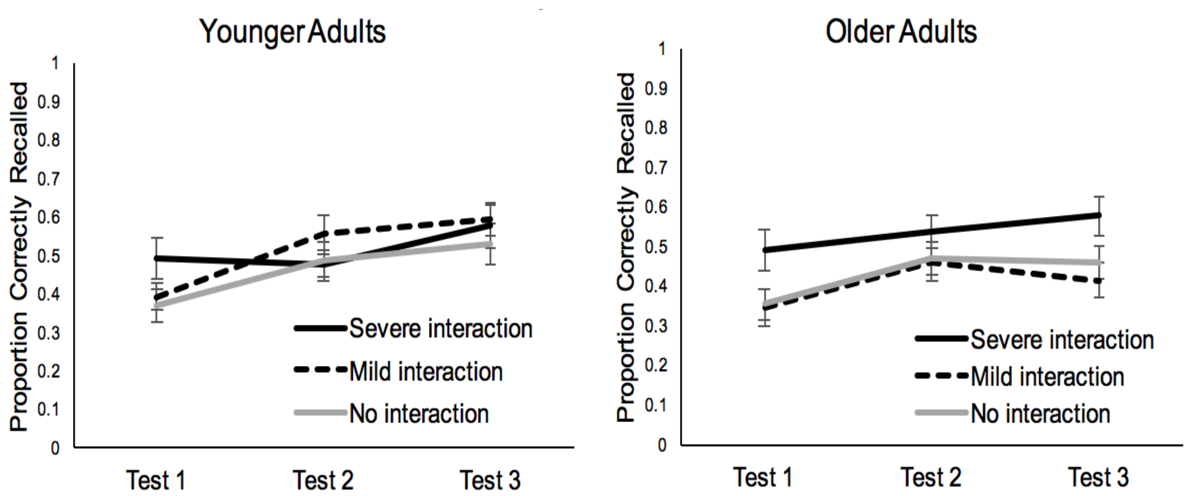

Figure 3.3. Performance on a series of three cued-recall tests in Experiment 2 by younger adults and older adults. Error bars represent standard error of the mean.

As in Experiment 1, we sought to rule out the explanation that older adults were biased toward choosing "severe." We again compared the amount of "severe" responses by each age group to 15, as there were 15 total "severe" interactions presented throughout the task. In Experiment 2, younger adults chose "severe" an average of 15.62 times (SD = 3.07), and older adults chose "severe" an average of 16.85 times (SD = 4.45). A one-sample t-test revealed that older adults chose "severe" marginally more than 15 times in Experiment 2, $t(25) = 2.12$, p = .045. There were no differences in the amount of severe responses given by younger and older adults, $t(50) = 1.16$, $p = .25$.

Discussion

Experiment 2 utilized a task that required multiple items to be bound together, depending on the interaction presented. If older adults had been detrimentally harmed by the size of the "fan" (i.e., the fact that one medication was linked with five others in different ways), this might have led to age-related differences, at least for the associative recognition accuracy of lower-value information, as older adults are often still able to remember information that is important. Older adults can be detrimentally affected by interference to a greater extent than younger adults, but interestingly, findings from the current study suggest that there are instances in which older adults are not significantly less accurate in remembering interfering medication information. The "fan" of interfering items does not differentially affect older adults in this case. When medication interactions are presented consecutively in a simplified format (that is, with only the name of the medication on the bottle) as they are in the current study, both age groups remember them equivalently well.

Unlike in Experiment 1, both age groups were similarly affected by severity, such that both remembered items associated with a severe health outcome more accurately than those associated with a mild health outcome or no significant health outcome. Though Figure 3.3 suggests that older adults differentially remembered severe outcomes more accurately than other outcomes, there was no interaction between age and severity, and the power to detect such differences was adequate (if using an effect size of 0.35, which is between moderate and high, the power to detect an effect given this design and sample size is 0.86). It is possible that the task in Experiment 2 was more difficult than in Experiment 1, causing even younger adults to struggle to encode and match every outcome with relatively high accuracy; that is, the introduction of the fan design made a value-based strategy more viable, rather than attempting to remember every item. Older adults chose "severe" slightly more often than it was presented, perhaps related to the difficulty of the task: if one cannot remember everything, it is perhaps beneficial to be cautious and assume that more items are dangerous. The lack of difference between memory for mild and no interaction items is interesting: perhaps severe items, because they are life-threatening, are considered important, whereas the other two categories are grouped together into a category deemed "less important." This pattern of results is similar to that of older adults in Experiment 1, providing further evidence for a possible division of stimuli into two categories by the participants when the task is considered challenging.

General Discussion

The current study examined how younger and older adults remember information about medication pairs that varied with respect to the level of danger associated with their interaction — severe, mild, or no interaction. In Experiment 1, each pair of items was unique and memory for the interaction between the two was tested. Though it was possible that participants remembered one item of the pair and the result (e.g., "Namenda is associated with a mild interaction"), this was still a test of the association between at least those two items. Younger and older adults performed equally well in Experiment 1, and only older adults' memory accuracy was affected by severity, suggesting sensitivity to the value-based structure in this study (or perhaps that the severe interactions were most distinct to the older adults, thereby leading to their more accurate recall).

In both experiments, the associative recognition accuracy of both groups increased given task experience. This is similar to prior work suggesting that older adults benefit from prior successful task performance (Geraci & Miller, 2013; Hargis & Castel, 2017; Kilb & Naveh-Benjamin, 2011), and suggests that repeated study and retrieval of associative information regarding medication interactions can benefit overall recall of important pairs of items, even when there are interfering connections among medications. Additionally, the information was tested via associative recognition in which there were three answer choices. If the study had been conducted such that the individual medications were tested, older adults may have performed less accurately than in the current study, but in the present task remembering that a certain pair of medications is dangerous to take together may be an effective value-based strategy. Experiment 2 employed a paradigm that was thought to lead to stronger effects of interference on remembering medication interactions, in light of previous work investigating the fan effect. The task was considered to be more difficult in that it was no longer possible to bind only one item of the pair to its outcome, as each medication appeared multiple times; indeed, Figure 3.3 suggests that both age groups were less accurate overall in Experiment 2. In this study, testing effects (Meyer & Logan, 2013) and value-based encoding processes (Castel, Farb, & Craik, 2007) may have helped both younger and older adults to remember important medication interactions. Neither younger nor older adults' amount of "severe" responses differed between experiment (older adults $t(50) = 1.47$, $p = .15$; younger adults $t(50) = 1.33$, $p = .19$), but the numerical shift seen toward choosing "severe" slightly more often in Experiment 2 may be related to the possible increase in task difficulty, as noted above. Perhaps when a task requires more cognitive effort or causes interference in memory, participants may be slightly more likely to be cautious and choose "severe" when in doubt of the answer or view the example outcomes (e.g., "dizziness") as severe, though the differences were not statistically significant.

It is worth noting, however, that the associative paradigm used here may allow for a type of gist-based encoding of the health outcome that would occur if two substances were consumed together. That is, participants may rely on the general gist of the outcome (e.g., "very dangerous" versus "not so bad") rather than the exact information presented during encoding. In aging, the ability to remember verbatim information can decline, but gist-based processing is often retained (e.g., Schacter, Koutstaal, Johnson, Gross & Angell, 1997; Titcomb & Reyna, 1995; Tun, Wingfield, Rosen & Blanchard, 1998). Previous work has suggested that memory for gist-based associative information can be as accurate in older as in younger adults, even if there are age-related deficits for verbatim associative information (Castel, 2005; Flores, Hargis, McGillivray, Friedman, & Castel, 2017). Further, since the test used in this paradigm is one of associative recognition, it is perhaps the case that some associative recognition tasks do not yield age-related associative deficits, while other value-based associative memory tasks using cued recall do indeed yield such differences (Ariel et al., 2015).

The present work suggests that the associative deficit often seen in older adulthood is not ubiquitous. While older adults typically suffer from impairments when interference is present (e.g., Jacoby, Debner, & Hay, 2001), there were no age differences in this study. This may have been because the test was simple (with three answer choices for each item), or perhaps older adults are actually able to overcome these deficits in interference when the to-be-learned information is valuable or meaningful (as opposed to a long list of word pairs). Future work may examine how this type of information is remembered in a more applied context, as the information in this study was presented on a computer screen (rather than as actual medication bottles, which may lead to more accurate recall), and may also directly assess the amount of experience participants have with taking multiple medications, further examining the impact of health on memory (Hess, 2005). It may also be of interest to pursue an explicit self-referencing manipulation (Gutchess et al., 2007), such that participants are asked to imagine that they are taking (or are actually prescribed) a subset of the medications they are asked to study. In summary, the present work shows that older adults may overcome deficits in binding to remember important medication interactions via value-based memory processes.

Experiment 3

It can be difficult to remember — and easy to confuse — health-related information. When learning about a complicated new diagnosis or treatment regimen, we may feel overwhelmed by the amount of information presented. It can be critical to remember, for example, important side effects of a medication, as the presence of certain side effects could indicate a serious condition for which the patient should seek additional treatment. However, patients forget up to 80% of medical information almost immediately upon encountering it (Kessels, 2003), and forgetting this type of information can have serious consequences, especially if one is unaware of their potential to forget. If the patient misremembers information about her own treatment plan, for example, or if a caregiver forgets information that is important to the loved one for whom she is providing care and cannot recall or relay that information later (see Nestojko, Bui, Kornell, & Bjork, 2014), medications can be omitted or taken incorrectly.

Patients often struggle to adhere to their doctors' recommendations; medication non-adherence in particular is a common and costly problem (Gellad, Grenard, & Marcum, 2011; Hughes, 2004; Roebuck, Liberman, Gemmill-Toyama, & Brennan, 2011). Many older adults take several medications at the same time (Qato et al., 2008), and these complex regimens may lead to older patients or caregivers confusing or misremembering medication information (especially in light of associative memory deficits, Naveh-Benjamin, 2000). Older adults do struggle more to adhere to medical regimens than their younger counterparts (Brown & Park, 2003; Morrell, Park, & Poon, 1990; Salzman, 1995). In the lab, schematic support can benefit older adults' performance in memory tasks (e.g., Castel, 2005; Friedman, McGillivray, Murayama, & Castel, 2015; cf. Morrow, Menard, Stine-Morrow, Teller, & Bryant, 2001), but that benefit is not always found when the to-be-learned information is in the medical domain (Rice & Okun, 1994), so older participants may struggle particularly with binding associative medical information in memory.

Metacognitive factors are also of interest in the current study. More specifically, metamemory (that is, our perceptions about how memory works) may influence how we learn and share medical information. Knowing what we do and do not know can help us more efficiently allocate attention and resources appropriately (Metcalfe, 2009; Metcalfe & Finn, 2008, Thiede, Anderson, & Therriault, 2003), and this type of monitoring may be especially important for older adults, as they often face cognitive declines (Rast & Zimprich, 2009). When learning new information in a physician's office or in a pharmacy, patients and caregivers may depend on their own abilities to remember information (such as a common side effect of their new medication) for later use. They may also consider, however, the memory abilities of the people with whom they will share that information. For example, a patient who has learned information during an appointment about a new diagnosis and wishes to share that information later with another person (perhaps a friend or spouse) would benefit from sharing the information in a way that is effective and clear, given the other person's memory capacity and potential limitations.

Family members often accompany patients, especially older adults, to medical appointments (Schilling et al., 2002). If a patient depends on another person who they brought to the appointment to remember information on their behalf, the helper's memory abilities will, of course, influence the accuracy of information that will later be relayed to the patient. Relying on another person to remember information can often be effective for the patient – it may free up cognitive resources to ask important questions of the doctor, for example (Prohaska & Glasser, 1996). However, the success of this process depends on the individual actually remembering the to-be-learned information; if the helper misremembers, that incorrect information may be passed along to the patient. Therefore, it would benefit the patient to have a general idea of how another person's memory works in a given situation and how much it should be trusted – that is, it would benefit the patient to have well-calibrated metamemory for themselves and others. As many older adults take several medications concurrently (Qato et al., 2008), knowledge of others' memory abilities may be especially helpful when keeping track of new information. Not all patients and caregivers have similar cognitive characteristics, however. Many younger people relay medical information to older people (e.g., in a personal setting as a caregiver to a grandparent or in an occupation such as pharmacy technician), and many older people relay medical information to younger people (e.g., family members or young patients). Patients may rely also rely on people from across the lifespan to help them remember, as collaborative remembering can lead to benefits above and beyond individual remembering for older adults (Harris, Keil, Sutton, Barnier, & McIlwain, 2011; Johansson, Andersson, & Rönnberg, 2005).

Extensive work has documented discrepancies between predicted performance and actual performance (e.g., Carroll, Nelson, & Kirwan, 1997; Castel, McCabe, & Roediger, 2007; Koriat & Bjork, 2005; Miller & Geraci, 2011a). Overconfidence in memory is fairly common; Schraw and Roedel (1994) suggest that overconfidence is largely due to participants not taking test difficulty into account when making judgments. There is evidence in the literature that older adults are as accurate in their metacognitive judgments as younger adults are (Halamish, McGillivray, & Castel, 2011; Hertzog & Hultsch, 2000; Rast & Zimprich, 2009), but other work suggests that older adults may be more overconfident in their judgments as compared to younger adults (Bruce, Coyne, & Botwinick, 1982; Devolder, Brigham, & Pressley, 1990). Often, if an individual misremembers a piece of advice or medication dosage instructions, they may not have a chance to remedy that misconception (doctor's appointments are shorter than ever, Landau, Bachner, Elishkewitz, Goldstein, & Barneboim, 2007; and the amount of information available on the internet is growing but not always trustworthy, Law, Mintzes, & Morgan, 2011). To allow for participants to learn about the fallible nature of memory, the current study compares perceptions about memory accuracy before and after a difficult learning task. In the current study, younger and older participants gave metacognitive judgments about their own and others' memory performance before and after a challenging memory task, to allow for an examination of how these judgments change with task experience via repeated study-test cycles.

Metacognition is often assessed by comparing item-by-item judgments of learning (JOLs) given by participants with accuracy across a task. In tasks with multiple study-test trials, participants' local judgments often reflect an underconfidence with practice (UWP) effect; their JOLs decrease across trials but their performance accuracy increases, which leads to a mismatch (England & Serra, 2012; Koriat, Sheffer, & Ma'ayan, 2002; see Rast & Zimprich, 2009 for an examination of UWP in older adults). Even with task experience, participants' metacognitive judgments may not accurately reflect their performance (Miller & Geraci, 2011b; Mueller, Dunlosky, & Tauber, 2015).

There have been several proposed accounts to explain the UWP effect, including that participants may rely on their memory for past tests to make current metacognitive judgments, leading them to be underconfident with task experience (Finn & Metcalfe, 2008; Tauber & Rhodes, 2012). Another account suggests that participants consistently anchor their judgments on the midpoint or lower on the confidence scale (e.g., between 30-50% on a scale from 0-100%; England & Serra, 2012; Scheck & Nelson, 2005). Using an anchor can be especially prevalent when the participant does not know much about the information they are being asked to judge (Scheck, Meeter, & Nelson, 2004). Younger and older adults may both use an anchoring heuristic, and the difference between estimated performance and actual performance can differ based on the difficulty of the memory task (e.g., Connor, Dunlosky, & Hertzog, 1997; see Price, Hertzog, & Dunlosky, 2008; Touron & Hertzog, 2004). The current task uses global metacognitive judgments; these types of judgments have been shown to be lower in magnitude (and can reflect less overconfidence) than single item-by-item judgments (Griffin & Tversky, 1992; Liberman, 2004; Treadwell & Nelson, 1996). Connor et al. (1997) demonstrated that younger and older adults become more accurate in their global predictions of performance after the memory task, and that they use the midpoint of the scale as an anchor under some circumstances.

It can be helpful to have accurate expectations about our own abilities and others', but these perceptions are often incorrect (Nickerson, 1999). Western participants often perceive themselves as better than average on certain tasks (e.g., Krueger & Dunning, 1999; Krueger & Mueller, 2002; Odean, 1998; Svenson, 1981; see Chapter 2, Study 3 of this Dissertation). However, the better-than-average (BTA) effect may depend on task difficulty: when making judgments about an easy task, people think they will perform better than average, but when faced with a difficult task, people think they will perform below the average (Kruger, 1999; see Johansson & Allwood, 2007 for an investigation of the below-average effect when rating others' knowledge). In the current experiments, though participants do not directly compare themselves to an average person, the cued recall task is designed to be challenging – if participants are sensitive to the difficulty of the task, they are expected to rate others as more accurate on the task than they themselves would be.

Memory often changes with age, and people across the lifespan believe that memory for information such as proper names is less accurate in older adulthood (Lineweaver & Hertzog, 1998; Ryan, 1992). Whether this belief informs expectations in the domain of memory for medication information has not been extensively studied.

The current study

We expect participants to be overconfident before realizing how challenging the learning task is, particularly when there is the potential for interference in memory (i.e., in Experiment 3). Participants often fail to appreciate how much interference can detrimentally affect performance (Diaz & Benjamin, 2011), but interference often occurs in real-world medical situations (e.g., when a new medication can cause headaches as a side effect, while a previous medication was associated with dizziness). Because participants do not have much information upon which to base their judgments before the task, we expect that pre-task global judgments will be primarily based on their overall beliefs about their cognitive abilities (Koriat, 2002). Further, if participants rely on a metacognitive anchor between 30-50% (Scheck & Nelson, 2005), we expect pre-task metacognitive judgments to be in this range.

In the current study, we ask participants to make judgments not only about their own performance, but also to estimate how they expect other people to perform. Learning in the medical domain often includes communicating information to others and relying on others to remember information for us. For example, an older adult patient may consider their own memory accuracy, but also the memory accuracy of their spouse in the same age group, as they may depend on their spouse to ask important questions during the appointment or help them with adhering to the medication regimen outside the doctor's office. Another older adult may consider their own memory for medical information to be poor (perhaps if they do not have much experience taking medications), but a peer may have more interest or experience (or both) and therefore have a more accurate memory for this type of information. Younger and older adults' judgments about early-career medical students may be particularly interesting: first-year medical students are often younger adults (e.g., in Dhalla et al., 2002), but they may be rated qualitatively differently than younger adults in general due to their potentially superior memorization abilities, their additional medical expertise, and/or their interest in the material. The current study investigated how younger and older adults perceived their own (and others') memory abilities, as well as their cued recall memory accuracy across four study-test cycles.

Experiment 3 examines how a difficult task might differentially impact younger and older adults' metacognitive judgment about multiple types of people. Overall, we expect that both age groups' pre-task estimates of performance will be inflated, particularly when rating medical students' performance, and when rating younger adults as individuals and groups (i.e., the "self" and "peer" categories for younger adult participants, and the "other age group" category for older adults). Participants of all ages may view younger adults and medical students as having superior memorization skills, interest in the material, and/or large capacities of cognitive resources that they could bring to bear in this task. Compared to ratings of younger adults and medical students, we expect overall that participants' predictions will be relatively lower when they rate the abilities of older adults as individuals and groups (i.e., the "self" and "peer" categories for older adult participants, and the "other age group" category for younger adults). We expect that participants in both age groups will be overconfident in their own performance before the task, as they will not take the difficulty of the task into account when making judgments, and we expect older adults' ratings of their own performance to be lower than their ratings of younger adults' performance.

We constructed the memory task to be difficult so that participants would have the opportunity to learn about their memory abilities and adjust their metacognitive ratings accordingly. Therefore, we expect cued recall performance to be relatively low on this task, and we expect older adults to perform worse than younger adults due to the associative nature of the task (Naveh-Benjamin, 2000) and the potential for memory interference (May, Hasher, & Kane, 1999). After the task, we expect a similar pattern of metacognitive judgments as were given before the task but lowered to be more reflective of participants' experiences.

Method

Participants

Younger adults (n = 24) were undergraduate students at University of California, Los Angeles (UCLA) and were recruited through the Psychology Department subject pool (M_{age} = 20.38, SD = 1.56), 22 were female, one other. Older adults (n = 26) were recruited from the Los Angeles community (M_{age} = 71.42, SD = 6.36), ten were female. This research was approved by the UCLA Institutional Review Board.

Materials and Procedure

Participants were asked to imagine that they were learning information about medications, some of which had been on the market for a substantial amount of time, and others that were new to the market. (In reality, half of the medications were fictitious, and half were real medications.) Participants told that they would learn and be tested on 18 pairs of medications and the side effects that may occur when consuming them (e.g., "headache"). Critically, they were told that they would then see *new* pairs on the following study list before they were tested again, and this would repeat for a total of four study-test cycles.

After reading the instructions, participants were asked to estimate, with the instructions in mind, "How do you think you will perform on this task?" and filled in the following blank: "I will remember ___% of the items presented in this task." On the same computer screen, participants were also asked to predict the performance (as a percentage) of the following people: an undergraduate student at UCLA, a first-year medical student, and a person between the ages of 60 and 85. Depending on the participants' age group, either the younger adult question or the older adult question was phrased as making a prediction about a "peer."

After making the pre-task judgments, participants began the memory task, in which they viewed each of 18 medication-side effect pairs (e.g., "Calamor : itching") for 5s. The pairs were presented in random order for each participant. Then participants were cued with each medication, one at a time, in random order, and asked to recall the side effect that was associated with that medication. This was repeated for a total of four study-test cycles, with new medications paired with the same set of side effects on each list to create interference (e.g., if "Calamor : itching" appeared on list one, list two could include "Zelnorm : itching").

All medication stimuli and side effects were taken from a previously normed database. Medications were rated to be similarly familiar ($M = 3.21$, $SD = 0.74$ on a scale from 1 to 5, 1 being "not familiar at all" and 5 being "very familiar"). Half were chosen to be fictitious to reduce the possible advantage (or possible interference) that might occur if certain participants were particularly knowledgeable about medications (see Hargis & Castel, 2018). Side effects were chosen from categories established by participants' ratings of how concerning they would find the experience of that side effect to be: six were rated by participants as mildly concerning ($M = 2.22$, $SD = 0.22$ on a scale from 1 to 5, 1 being "not concerning at all" and 5 being "very concerning"), six as moderately concerning ($M = 2.73$, $SD = 0.14$ on a scale from 1 to 5), and six as highly concerning ($M = 3.51$, $SD = 0.25$ on a scale from 1 to 5). These categories were not made explicit to the participants and were not a main variable of interest. The distinction between the categories, especially between "mild" and "moderate" side effects, was relatively small.

After completing the four study-test cycles, participants were reminded of the task instructions and asked to make post-task metacognitive judgments. These judgments were similar to the pre-task ratings, except that participants were asked "How do you think you performed on this task?" and filled in the following blank: "I remembered __% of the items presented in this task." Judgments were made for each category: oneself, a peer of the same age group, a first-year medical student, and a member of the opposite age group.

Results

Metacognitive judgments

Younger and older adults' metacognitive judgments are displayed in Figure 3.4. The metacognitive judgments were first submitted to a 2 (age group) x 2 (time of judgment: pre-task vs post-task) 4 (type of judgment: self, peer, medical student, other age group) mixed-factorial analysis of variance (ANOVA). This test revealed no three-way interaction, $F(3, 144) = 1.90$, $p = .13$, $\eta^2 = .002$. There were, however, three significant two-way interactions. There was a significant interaction between time of judgment and type of judgment, $F(3, 144) = 10.84$, $p < .001$, $\eta^2 = .009$. There was also a significant interaction between type of judgment and age group, $F(3, 144) = 35.37$, $p < .001$, $\eta^2 = .06$, and a significant interaction between time of judgment and age group, $F(1, 48) = 12.63$, $p < .001$, $\eta^2 = .019$.

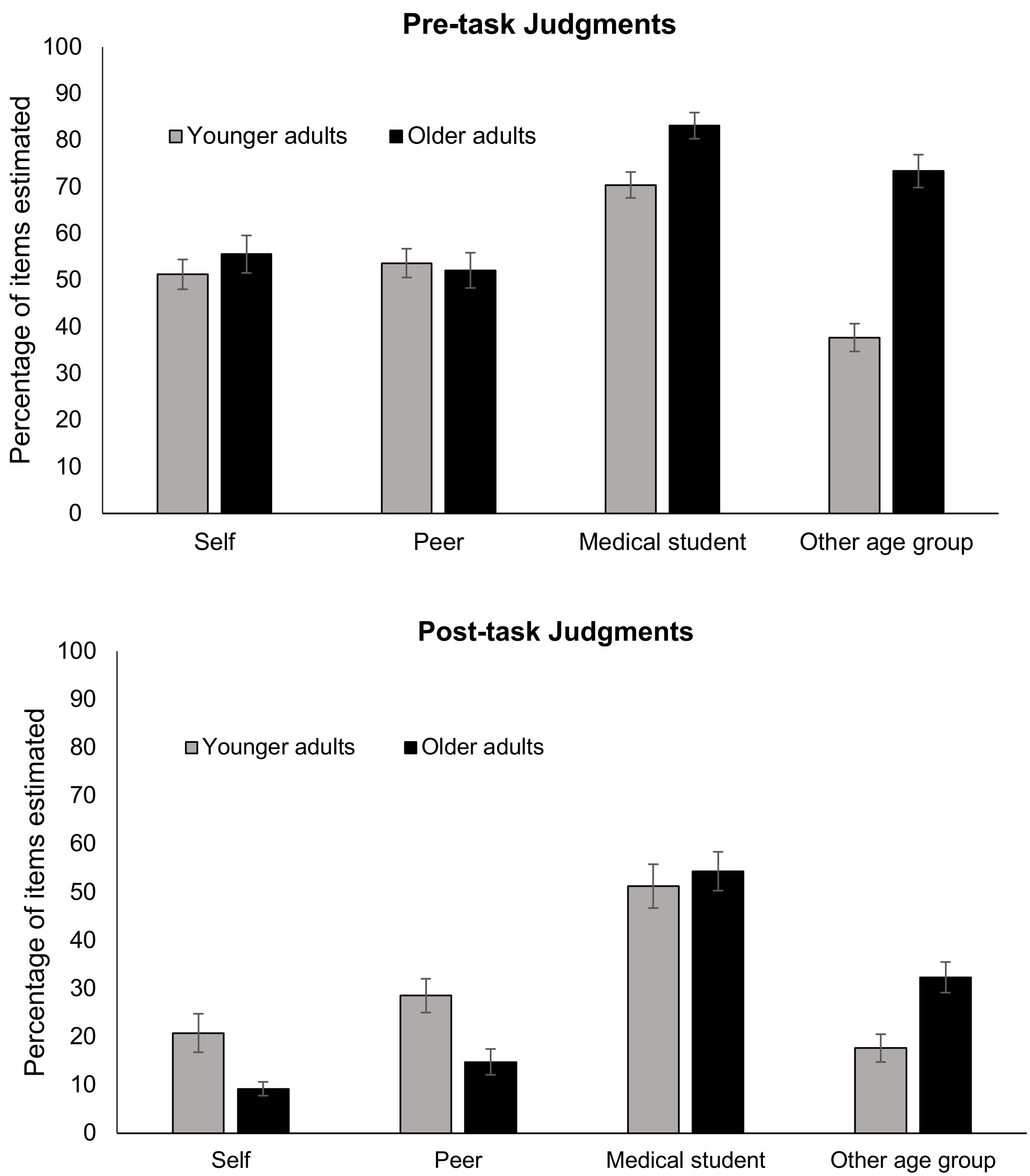

Figure 3.4. Metacognitive judgments given in Experiment 3 before (top panel) and after (bottom panel) the memory task. Participants estimated what percentage of items the following groups would recall: themselves, a peer of the same age group, a first-year medical student, and a member of the other age group. Error bars represent standard error.

To decompose the interaction between time of judgment (pre-task vs post-task) and type of judgment (self, peer, medical student, other age group), we conducted a one-way ANOVA to assess the effect of type of judgment on the pre-task estimates. This test revealed a main effect of type of judgment, $F(3, 147) = 42.60$, $p < .001$, $\eta^2 = .22$. Post-hoc *t*-tests (with Bonferroni corrections) revealed that in the pre-task judgments, participants did not rate themselves (M = 53.50, SD = 18.42) differently than they rated their peers (M = 52.86, SD = 17.22), $t(49) = .41$, $p = .69$, Cohen's $d = .06$. They did, however, expect medical students (M = 77. 03, SD = 15.24) to be more accurate on the test than they themselves would be, $t(49) = 10.10$, $p < .001$, $d = 1.43$ and more accurate than their peers would be, $t(49) = 11.06$, $p < .001$, $d = 1.56$. Participants on average also predicted that medical students would be more accurate than the opposite age group (M = 56.26, SD = 24.73), $t(49) = 8.53$, p <. 001, $d = 1.21$. All other post-hoc tests did not reach significance, *p*s > .18. We also conducted a one-way ANOVA to assess the effect of type of judgment on the post-task estimates, and found a main effect of type of judgment, $F(3, 147) = 75.60$, $p < .001$, $\eta^2 = .41$. Post-hoc *t*-tests followed similar patterns to the tests conducted on the pre-test estimates: participants rated that medical students (M = 52.86, SD = 21.21) would get a higher percentage of correct responses than they (M = 14.78, SD = 15.51) would, $t(49) = 12.22$, $p < .001$, d = 1.73, and that their peer (M = 21.40, SD = 16.78) would, $t(49) = 11.35$, $p < .001$, $d = 1.61$. Participants also gave higher post-task estimates for medical students than they did for members of the opposite age group (M = 25.30, SD = 16.79), $t(49) = 9.42$, $p < .001$, $d = 1.33$. There was not a significant difference in participants' ratings of themselves and a person of the opposite age group, $t(49) = 1.39$, $p = .17$, $d = .20$.

To investigate the interaction between type of judgment and participants' age group, we conducted a one-way ANOVA to assess the effect of type of judgment on younger adults' estimates, which revealed a main effect of type of judgment, $F(3, 69) = 48.10$, $p < .001$, $\eta^2 = .45$. Post-hoc *t*-tests indicated that younger adults did not rate themselves ($M = 36.02$, $SD = 14.05$) differently from their peers ($M = 41.10$, $SD = 13.68$) on this task, $t(23) = 2.25$, $p = .03$, $d = .46$ (significance did not survive Bonferroni correction). Younger adults rated themselves and their peers as less accurate overall than a medical student would be ($M = 60.83$, $SD = 14.97$), $t(23) = 6.91$, $p <.001$, $d = 1.41$ and $t(23) = 7.34$, $p <.001$, $d = 1.50$, respectively. Medical students were rated as more accurate than were older adults ($M = 27.69$, $SD = 11.97$), $t(23) = 10.36$, $p <.-01$, $d = 2.12$. Younger participants rated themselves as more accurate than older adults, $t(23) = 2.93$, $p < .01$, $d = .61$, and they rated their peers as more accurate than older adults, $t(23) = 5.40$, $p <.001$, $d = 1.10$.

A one-way ANOVA assessing the effect of type of judgment on older adults' estimates also revealed a main effect of type of judgment, $F(3, 75) = 141.00$, $p <.001$, $\eta^2 = .53$. Post-hoc *t*-tests revealed that older adults' estimates were similar to younger adults' estimates (*p*s < .001), with one primary difference: while younger adults rated themselves as more accurate than older adults in this task, older adults rated themselves ($M = 32.40$, $SD = 12.53$) as less accurate than younger adults ($M = 52.87$, $SD = 14.25$), $t(25) = 10.30$, $p <.001$, $d = 2.02$, as was expected. Similarly to younger adults, older adults did not rate themselves differently from their peers ($M = 33.46$, $SD = 14.50$), $t(25) = 0.68$, $p = .50$, $d = .134$. Older adults also estimated that medical students ($M = 68.74$, $SD = 15.84$) would do better on this task than they would, $t(25) = 14.98$, $p < .001$, $d = 2.94$.

Finally, we investigated the interaction between time of judgment and age group by conducting independent samples *t*-tests. We compared younger adults' pre-task judgments to older adults' pre-task judgments and found that overall, younger adults' ratings (M = 53.26 , SD = 12.02) were lower than older adults' ratings (M = 66.05, SD = 16.36) before the task, $t(48)$ = 3.13, $p < .01$, d = .89, likely driven by the differences between younger adults' ratings of older adults and vice versa. We then compared younger adults' post-task judgments to older adults' post-task judgments and found no difference between younger (M = 29.56, SD = 14.78) and older adults' ratings (M = 27.68, SD = 11.77) after the task, $t(48)$ = 0.50, p = .62, d = .14.

Accuracy

Younger and older adults' memory accuracy across the task is displayed in Figure 3.5. To investigate how younger and older adults' cued recall performance changed across the task, we conducted a 2(age group) x 4 (test) ANOVA, which revealed a non-significant interaction between age and test, $F(3, 144)$ = 2.10, p = .102, η^2 = .008 (see Figure 3.5). There was a significant main effect of age, $F(1, 48)$ = 15.50, $p < .001$, η^2 = .193, such that younger adults (M = 29.63, SD = 23.38) recalled a higher percentage of the items than older adults did (M = 12.45, SD = 9.75) across the task.

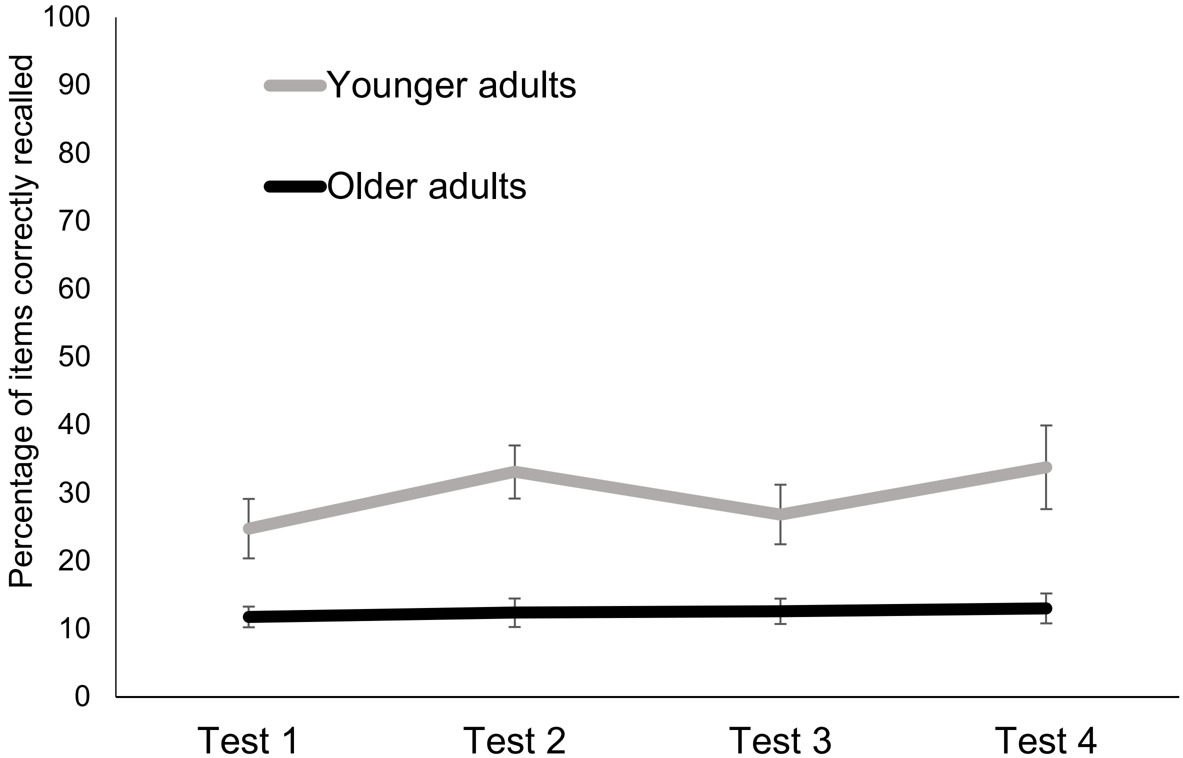

Figure 3.5. The percentage of side effects accurately recalled when presented with the associated medication in Experiment 3. Error bars represent standard error.

There was also, somewhat unexpectedly, a main effect of test, $F(3, 144) = 2.96$, $p = .035$, $\eta^2 = .0012$, such that participants' performance increased across the task. More specifically, participants' performance increased between Tests 1 ($M = 18.00$, $SD = 17.01$) and 2 ($M = 22.33$, $SD = 18.42$), $t(49) = 2.23$, $p = .03$, $d = .32$, but not significantly between Tests 2 and 3 ($M = 19.44$, $SD = 17.72$), $t(49) = 1.66$, $p = .10$, $d = .24$, or between Tests 3 and 4 ($M = 23.00$, $SD = 24.51$), $t(49) = 1.66$, $p = .10$, $d = .23$. Accuracy was higher on the final test than on the initial test, $t(49) = 2.20$, $p = .03$, $d = .31$, suggesting that some learning did take place across the task. This pattern was unexpected as there were new pairs presented on each study trial, but perhaps participants became better acquainted with the list of side effects (e.g., "itching" was used on each learning phase, paired with a different medication) and were better able to learn the associations after being repeatedly exposed to the side effects. However, if a Bonferroni correction for multiple comparisons is applied, none of the above differences reach significance (corrected alpha = .0125).

Accuracy of metacognitive judgments

To compare metacognitive judgments with actual performance, we conducted a 2 (age group) x 3 (pre-task judgment of one's own performance, actual performance, post-task judgment of one's own performance) mixed ANOVA. This test revealed a significant main effect of age group, $F(1, 48) = 5.65$, $p = .02$, $\eta^2 = .03$ and a significant main effect of pre-task judgment, actual performance, and post-task judgments, $F(2, 96) = 123.34$, $p < .001$, $\eta^2 = .50$; there was also a significant two-way interaction, $F(2, 96) = 8.99$, $p <.001$, $\eta^2 = .04$. Figures 3.4 and 3.5 suggest larger differences between older adults' judgments and performance than younger adults'. To decompose the interaction, we conducted a one-way ANOVA for each age group. The ANOVA for younger adults revealed a significant difference between pre-task judgments, actual performance, and post-task judgments, $F(2, 46) = 30.40$, $p < .001$, $\eta^2 = .33$, as did the ANOVA for older adults', $F(2, 50) = 114.00$, $p <. 001$, $\eta^2 = .72$. Post-hoc paired-samples *t*-tests revealed that younger adults' pre-task judgments about themselves were higher than their actual performance, $t(23) = 4.37$, $p < .001$, $d = .89$ and higher than their post-task performance $t(23) = 6.92$, $p < .001$, $d = 1.41$. Younger participants' post-task judgments were significantly lower than their actual performance, $t(23) = 4.08$, $p < .001$, $d = .83$. Taken together, these results reveal younger participants' overconfidence before the task and underconfidence after the task. Similar tests were conducted to examine older adults' judgments and accuracy, revealing that older adults' pre-task ratings of their own performance were higher than their actual performance, $t(25) = 9.72$, $p < .001$, $d = 1.91$ and were also higher than their post-task ratings, $t(25) = 13.32$, $p <.001$, $d = 2.61$. There was not a significant difference between older adults' actual performance and their post-task rating of that performance, $t(25) = 1.72$, $p = .10$, $d = .34$, suggesting that older adults give appropriate metacognitive judgments after the task.

Additional analyses

Though it was not a main variable of interest and the differences among categories were minimal, we also sought to determine whether the severity of the side effect influenced younger or older adults' performance (see Experiments 1 and 2 in the current Chapter for an example of severity affecting older adults', but not younger adults' performance). To do this, we conducted a 2(age group) x 3(severity) ANOVA, which revealed a marginally significant interaction between age and severity, $F(2, 96) = 3.17$, $p = .05$, $\eta^2 < .01$. Though this interaction was marginally statistically significant, we decomposed it to explore the potential interactive effect of age and severity. We conducted a one-way ANOVA on younger adults' memory performance and found a significant effect of severity, $F(2, 46) = 4.33$, $p = .02$, $\eta^2 = .02$. Post-hoc *t*-tests revealed younger adults recalled moderate side effects ($M = 32.64$, $SD = 23.97$) more accurately than they recalled mild side effects ($M = 25.87$, $SD = 20.89$), $t(23) = 2.87$, $p < .01$, $d = .59$, all other differences were non-significant, *p*s > .06. Older adults' performance, however, was not affected by the severity of the side effect, $F(2, 50) = 1.33$, $p = .27$, $\eta^2 = .02$.

As half of the medications were real medications that could be found on the market and half were fictitious (but realistic) medications, we sought to determine whether recall differed based on whether the medication was real or not. We did not expect that younger and older adults would differ in their recall of real versus fictitious medications. We conducted a 2 (age group) x 2(realness of medication) mixed ANOVA, and found no interaction between age and realness of medications, $F(1, 48) = 0.51$, $p = .48$, $\eta^2 < .01$.We did find, however, a main effect of realness of medications, $F(1,48) = 23.62$, $p < .001$, $\eta^2 = .03$, such that the side effects of real medications ($M = 23.83$, $SD = 18.23$) were recalled more accurately than the side effects of fictitious medications ($M = 17.56$, $SD = 18.02$). (As reported above, younger adults did outperform older adults on this task, $F(1, 48) = 15.50$, $p < .001$, $\eta^2 = .22$.).

Discussion

In Experiment 3, younger and older adults studied pairs of medications and their side effects during four study-test trials. This task was designed to be difficult for both age groups, to examine the extent to which a challenging memory task could affect metacognitive ratings of oneself and others. After reading the instructions but before studying any words, both younger and older participants estimated that they and their peer would remember approximately 50% of the items presented (similarly to previous work investigating metacognitive anchoring near the midpoint of the scale; Scheck & Nelson, 2005). Pre-task ratings of the opposite age group (i.e., younger adults estimating older adults' performance and vice versa) were in line with previous work about how memory is expected to change across the lifespan (Ryan, 1992). Both age groups estimated that medical students would perform fairly accurately on this task.

Though some work suggests that global metacognitive judgments often reflect underconfidence (Liberman, 2004; Treadwell & Nelson, 1996), actual cued recall performance was lower than the predicted 50% accuracy, and older adults in particular struggled to remember the pairs accurately. Age-related deficits for associative information have been found in many domains (Naveh-Benjamin, 2000), and the potential for memory interference present in the current design (due to the same side effects being paired with new medications on each list) likely served to further lower older participants' performance. There was a significant main effect of test on accuracy, and though the interaction between test and age did not reach statistical significance, Figure 3.5 illustrates a pattern than younger adults improved slightly across the task whereas older adults' performance was fairly consistent (and consistently low; see Geraci & Miller, 2013).

After the memory task, participants completed the same metacognitive judgments as before about themselves and others, and all judgments were significantly lowered. The pre-task bias towards overconfidence was no longer present; indeed, younger adults' post-task judgments were significantly lower than their actual performance, while older participants' post-task ratings were not different from their actual performance. This finding is in line with previous work suggesting that older adults' JOLs do not reflect an underconfidence-with-practice effect (Rast & Zimprich, 2009) and that older adults' metacognitive judgments are often fairly accurate (Halamish et al., 2011; Hertzog & Hultsch, 2000). Perhaps younger adults' underconfidence in their own performance could be adaptive in this setting: expecting to remember less medical information than one actually would recall may lead that person to devote extra resources and attention toward learning it (Metcalfe, 2009; Metcalfe & Finn, 2008, Thiede, Anderson, & Therriault, 2003). Interestingly, both age groups still estimated medical students would perform fairly accurately compared to oneself, perhaps because they believe that medical students are particularly adept at memorizing and learning new information about their specialty, or perhaps they assumed that medical students would be more interested in the content and would therefore devote more effort toward learning the pairs (see Kruger, 1999; Johansson & Allwood, 2007).

Additional analyses suggest that younger adults did remember mildly concerning side effects (e.g., flushing) more accurately than moderately concerning side effects (e.g., nausea). Since those categories were not explicitly delineated, we did not expect that participants would remember them differently; previous work that found effects of severity on performance used paradigms that emphasized the severity of the outcome (e.g., Friedman et al., 2015; Hargis & Castel, 2018; Middlebrooks et al., 2015). Medications that are actually on the market were recalled more accurately than fictitious medications, which may indicate that participants were able to use some schematic support for the real medication stimuli (see also Morrow, Menard, Stine-Morrow, Teller, & Bryant, 2001; Rice & Okun, 1994).

Participants in Experiment 3 were not given the opportunity to re-study (and thereby strengthen the memory trace of) pairs of medications and their side effects after they were tested on the pairs. Older participants in particular performed poorly in the memory task in Experiment 3, so we sought in Experiment 4 to ensure that performance would not be near the floor (similarly to Experiments 1 and 2 in Connor et al., 1997). Experiment 4 allows for re-study and better reflects real-life learning situations in which repeated exposure to material could occur.

Experiment 4

As discussed in Experiment 3, highly confident memory errors can have consequences. In the medical domain, patients may think they will remember what the physician is relaying (and therefore do not take effective notes, or do not take notes at all), only to find that, once they leave the doctor's office, much of the information is now forgotten (Kessels, 2003). Experiment 4 examined how younger and older people assess their performance on a challenging associative memory task, and how those estimates may change with task experience.

Instead of side effects that are randomly paired with new medications on each list (as in Experiment 1), Experiment 4 holds constant the medication : side effect pairings throughout the task, such that each pair is studied and tested a total of four times. Prior work suggests older adults benefit from successful prior task performance (Geraci & Miller, 2013); in the current

Experiment, participants have the opportunity to learn across several lists (Kilb & Naveh-Benjamin, 2011). Even though direct comparisons cannot be made between Experiments 3 and 4, it is interesting to examine whether a separate group of participants' predictions will in fact be different based solely on a change to the instructions that reflects the consistent pairing of medications with their side effects (see also Experiments 1 and 2 in Connor et al., 1997).

If younger and older adults are able to learn from task experience as in prior work examining associative memory for medical information (e.g., Hargis & Castel, 2018), we predict that younger and older adults' cued recall performance will increase in accuracy across the task. Previous work suggests that older adults face deficits in associating information in memory if that information is unrelated (e.g., Naveh-Benjamin, 2000). Therefore, as in Experiment 3, we predict that younger adults will outperform older adults, as the task at hand is still quite difficult. If participants use an anchoring heuristic (Scheck & Nelson, 2005), they may estimate that they will remember "about half" of the items, regardless of the specific task requirements. We expect that potential overconfidence will be at least somewhat remedied after the memory task is complete, such that ratings will be adjusted downward to be closer to actual performance (that is, performance estimates will be more accurate after participants finish the memory task).

Method

Participants

Younger adults (*n* = 26) were undergraduate students at UCLA and were recruited through the Psychology Department subject pool (M_{age} = 20.31, *SD* = 2.00), 19 were female. Older adults (*n* = 26) were recruited from the Los Angeles community (M_{age} = 75.35, *SD* = 6.75), 11 were female. None had participated in Experiment 3. This research was approved by the UCLA Institutional Review Board.

Materials and Procedure

The materials and procedure of this study were the same as Experiment 3, except that participants studied the same 18 pairs of medications and side effects on each list, and this same list repeated for a total of four study-test cycles. Participants were told this information before they answered the pre-task metacognitive questions, which were the same as in Experiment 3, as were the post-task metacognitive questions.

Results

Metacognitive judgments

Younger and older adults' metacognitive judgments are displayed in Figure 3.6. Similarly to Experiment 3, to analyze metacognitive judgments we conducted a 2 (age group) x 2 (time of judgment: pre-task vs post-task) x 4 (type of judgment: self, peer, medical student, other age group) ANOVA. This test revealed a significant three-way interaction, $F(3, 150) = 5.61$, $p < .001$, $\eta^2 = .003$. To decompose this interaction, we conducted a 2(time of judgment) x 2(type of judgment) within-subjects ANOVA for younger adults, which revealed a non-significant two-way interaction, $F(3, 75) = 1.31$, $p = .28$, $\eta^2 = .02$. There was a significant main effect of time of judgment, $F(1, 25) = 14.36$, $p < .001$, $\eta^2 = .23$, such that ratings given before the task (M = 52.51, SD = 19.91) were lower than ratings given after the task (M = 70.17, SD = 29.03). This test also revealed a significant main effect of type of judgment, $F(3, 75) = 59.76$, $p < .001$, $\eta^2 = .19$. We further investigated this main effect using a series of paired-samples t-tests with Bonferroni corrections. The only comparison that failed to achieve significance after the correction was between younger adults' ratings of themselves (M = 62.56, SD = 27.56) and their peers (M = 60.65, SD = 24.45), $t(23) = 2.25$, $p = .03$, $d = .46$. Younger adults rated themselves as less accurate than medical students (M = 77.25, SD = 19.96), $t(23) = 6.91$, $p < .001$, $d = 1.41$ and more accurate than older adults (*M* = 44.90 , *SD* = 23.01), $t(23) = 2.97$, $p = .007$, $d = .61$.Younger adults rated their peers to be less accurate than a medical student would be, $t(23) = 7.34$, $p < .001$, $d = 1.50$, but more accurate than older adults, $t(23) = 5.40$, $p < .001$, $d = 1.10$. They also estimated that medical students would be more accurate than older adults, $t(23) = 10.36$, $p < .001$, $d = 2.12$.

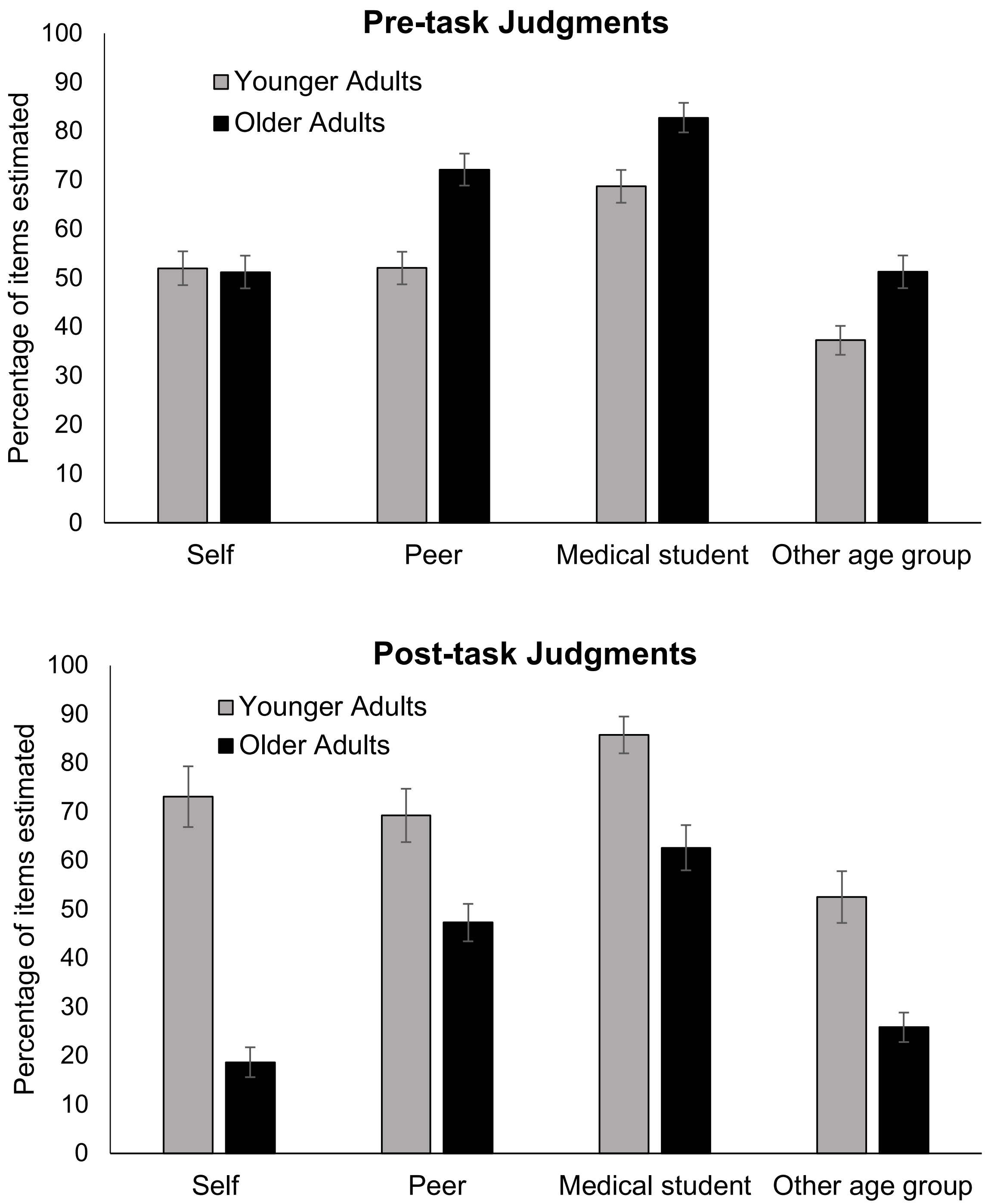

Figure 3.6. Metacognitive judgments given in Experiment 4 before (top panel) and after (bottom panel) the memory task. Participants estimated what percentage of items the following groups would recall: themselves, a peer of the same age group, a first-year medical student, and a member of the other age group. Error bars represent standard error.

To further decompose the significant three-way interaction, we conducted (at the older adult participant level) a 2(time of judgment) x 4 (type of judgment) within-subjects ANOVA, which, unlike in younger adults, did reveal a significant two-way interaction $F(3, 75) = 5.89$, $p = .001$, $\eta^2 = .007$. There was a main effect of type of judgment, $F(3, 75) = 71.85$, $p < .001$, $\eta^2 = .34$, and a main effect of time of judgment, $F(1, 25) = 75.89$, $p < .001$, $\eta^2 = .23$. To decompose the interaction, we compared pre-task and post-task judgments at each level of the type of judgment variable (self, peer, medical student, and other age group). Older adults gave significantly higher estimates of their own performance pre-task ($M = 51.23$, $SD = 17.04$) than post-task ($M = 18.69$, $SD = 15.59$), $t(25) = 9.16$, $p < .001$, $d = 1.80$. They also gave significantly higher estimates of their peers' performance pre-task ($M = 72.15$, $SD = 16.64$) than post-task ($M = 47.31$, $SD = 19.56$), $t(25) = 7.20$, $p < .001$, $d = 1.41$, and higher estimates of medical students' performance pre-task ($M = 82.77$, $SD = 15.41$) than post-task ($M = 62.65$, $SD = 23.64$), $t(25) = 6.41$, $p < .001$, $d = 1.26$. Older adults also gave higher ratings of the opposite age group's performance (i.e., younger adults' performance) pre-task ($M = 51.27$, $SD = 15.59$) than post-task ($M = 25.85$, $SD = 15.40$), $t(25) = 6.82$, $p < .001$, $d = 1.34$.

Accuracy

Younger and older adults' memory accuracy across the task is displayed in Figure 3.7. To investigate how younger and older adults' memory performance changed across the task, we conducted a 2(age group) x 4 (test) ANOVA. This test revealed a main effect of age, $F(1, 50) = 79.30$, $p < .001$, $\eta^2 = .40$, such that younger adults ($M = 63.14$, $SD = 20.14$) outperformed older adults overall ($M = 19.76$, $SD = 14.53$).

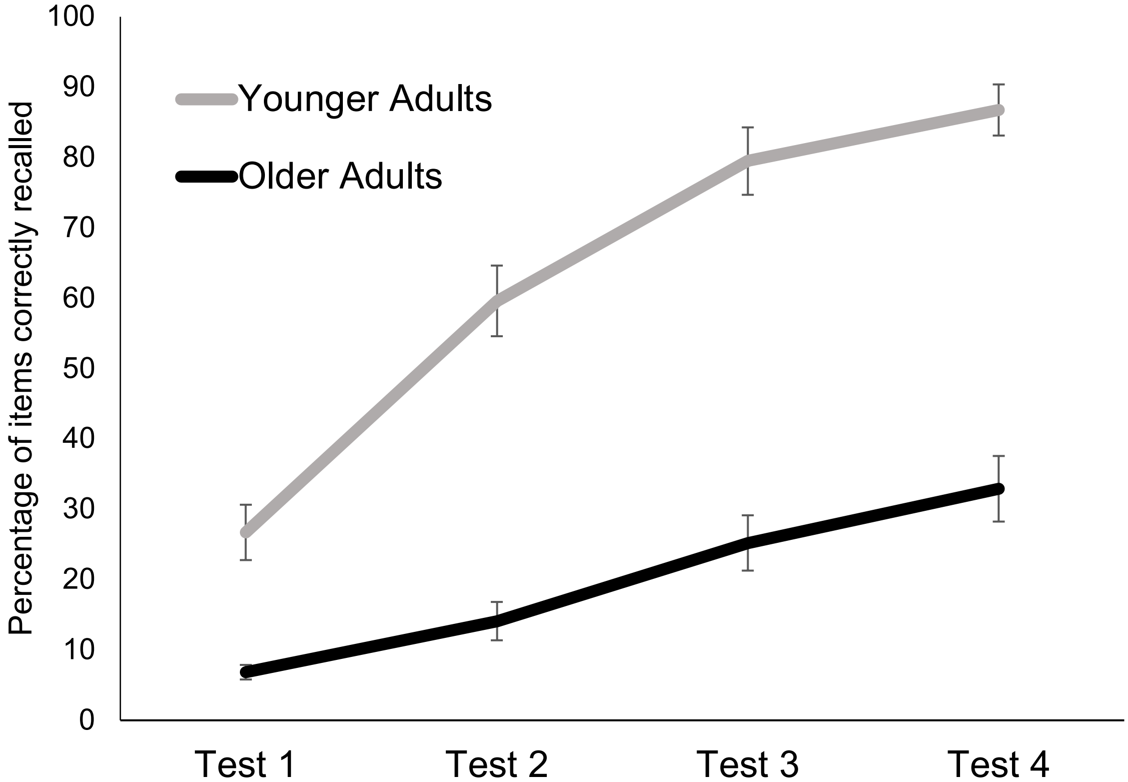

Figure 3.7. The percentage of side effects accurately recalled when presented with the associated medication in Experiment 4. Error bars represent standard error.

The test also revealed a significant interaction between age and test, $F(3, 150) = 27.80$, $p < .001$, $\eta^2 = .23$. We then conducted a one-way within-subjects ANOVA to assess how younger adults' accuracy changed across the task, which revealed a main effect of test, $F(3, 75) = 150.00$, $p < .001$, $\eta^2 = .53$. Post-hoc paired-samples *t*-tests were conducted with Bonferroni correction; the corrected alpha was .0167 for three comparisons. These tests revealed that performance on Test 2 ($M = 59.61$, $SD = 25.61$) was better than on Test 1 ($M = 26.71$, $SD = 20.01$), $t(25) = 10.47$, $p < .001$, $d = 2.05$, and performance on Test 3 ($M = 79.49$, $SD = 24.43$) was better than on Test 2,

$t(25) = 8.45$, $p < .001$, $d = 1.66$. Performance on Test 4 ($M = 86.75$, $SD = 18.53$) was better than on Test 3, $t(25) = 2.34$, $p < .01$, $d = .69$.

To assess how older adults' memory accuracy changed across the task, we conducted a one-way within-subjects ANOVA, which revealed a main effect of test, $F(3, 75) = 29.00$, $p < .001$, $\eta^2 = .26$. Post-hoc paired-samples *t*-tests were conducted with Bonferroni correction; similarly to above, the corrected alpha was .0167. Older adults' performance on Test 1 ($M = 6.84$, $SD = 5.28$) was significantly lower than performance on Test 2 ($M = 14.10$, $SD = 13.90$), $t(25) = 3.13$, $p < .01$, $d = .61$, and performance on Test 3 ($M = 25.21$, $SD = 20.04$) was significantly better than performance on Test 2, $t(25) = 6.09$, $p <.001$, $d = 1.20$. Performance on Test 4 ($M = 32.91$, $SD = 23.77$) was also significantly better than performance on Test 3, $t(75) = 2.53$, $p < .01$, $d = .63$.

Accuracy of metacognitive judgments

As in Experiment 3, we conducted a 2 (age group) x 3 (pre-task judgments of one's own performance, actual performance, post-task judgments of one's own performance) mixed ANOVA to assess participants' relative overconfidence and/or underconfidence. Similarly to Experiment 3, there was a significant main effect of age, $F(1, 50) = 55.80$, $p < .001$, $\eta^2 = .32$, and a significant main effect of pre-task judgment, actual performance, and post-task judgment, $F(2, 100) = 3.49$, $p = .03$, $\eta^2 = .02$. There was also a significant two-way interaction, $F(2, 100) = 37.25$, $p < .001$, $\eta^2 = .16$. Figures 3.6 and 3.7 suggest that both age groups' initial judgments were anchored approximately at the midpoint of the 0-100% scale, and that younger adults' judgments about their own performance increased after the task, whereas older adults' judgements decreased. We conducted a one-way ANOVA on younger adults' judgments and accuracy which revealed a significant main effect, $F(2, 50) = 9.83$, $p <.001$, $\eta^2 = .12$. Post-hoc paired-samples *t*-tests revealed that younger adults' pre-task ratings were significantly higher than their actual performance, $t(25) = 14.92$, $p < .001$, $d = 2.93$, and their post-task ratings were also significantly higher than their actual performance , $t(25) = 11.71$, $p <.001$, $d = 2.30$. Younger adults' post-task ratings were significantly higher than their pre-task ratings, $t(25) = 3.53$, $p < .01$, $d = .69$. The one-way ANOVA on older adults' accuracy and judgments revealed a significant main effect, $F(2, 50) = 33.30$, $p <.001$, $\eta^2 = .46$. Older adults' pre-task ratings were higher than their actual performance, $t(25) = 15.23$, $p <.001$, $d = 2.99$, and their post-task ratings were also higher than their actual performance, $t(25) = 6.03$, $p < .001$, $d = 1.18$. Unlike younger adults, however, older adults' post-task ratings were significantly lower than their pre-task ratings, $t(25) = 9.16$, $p <.001$, $d = 1.80$.

Additional analyses

As in Experiment 3, we tested whether the severity of the side effect influenced younger or older adults' performance using a 2(age group) x 3(severity) mixed-subjects ANOVA. This test revealed a non-significant two-way interaction, $F(2, 100) = 0.11$, $p = .90$, $\eta^2 < .01$. There was no main effect of severity, $F(2, 100) = 0.88$, $p = .42$, $\eta^2 < .01$. (As explored above, there was a main effect of age group on accuracy, $F(1, 50) = 79.30$, $p <.001$, $\eta^2 = .56$, such that younger adults outperformed older adults across the task).

We also conducted a 2(age) x 2(real vs fictitious) mixed ANOVA to determine whether fictitious and real medications were remembered differently. This test revealed a significant two-way interaction, $F(1, 50) = 6.85$, $p = .01$, $\eta^2 = .01$. Paired-samples *t*-tests revealed that younger adults did not remember real ($M = 61.55$, $SD = 21.70$) and fictitious ($M = 62.93$, $SD = 19.59$) medications differently, $t(25) = 0.56$, $p = .58$, $d = 0.11$, but older adults remembered the side effects of real medications ($M = 26.28$, $SD = 17.61$) more accurately than of fictitious medications ($M = 18.80$, $SD = 14.21$), $t(25) = 3.06$, $p = .01$, $d = 0.60$.

Discussion

Experiment 4 was similar to Experiment 3, except that it allowed for more learning to occur across the task as participants learned the pairing between a medication and its side effect during four study-test cycles. If participants were to take the task requirements into account, we expected that pre-task ratings would be higher in Experiment 4 than in Experiment 3, since the memory task is objectively easier. Alternatively, we expected that if participants were to base their pre-task judgments on a metacognitive anchor (Scheck & Nelson, 2005) rather than the specific task demands, then participants' pre-task judgments would not be different from Experiment 3. Before the task, younger and older adults estimated that they would remember approximately 50% of the items correctly. The similarities in pre-task judgments from Experiments 3 and 4 may represent a general metacognitive anchor in that regardless of the specifics of the task, people expect to remember about half of the information presented (England & Serra, 2012; Scheck et al., 2004; Scheck & Nelson, 2005). Participants also rated medical students as more accurate than themselves and their peers. Each of the older adults' metacognitive judgments were higher pre-task than post-task, but Figure 3.6 suggests that there is more of a discrepancy between pre-task and post-task ratings of their own performance compared to others'. That is, though all of older adults' judgments decreased after the memory task, judgments about their own performance decreased to what appears to be a greater extent than judgment about others' performance (which is supported by the effect size of this difference compared to the other differences).

We predicted a main effect of age on memory performance such that younger adults outperform older adults, perhaps due to the difficulty of the associative component of this task (Naveh-Benjamin, 2000) and the interference that can be caused by the side effects, which can differentially affect older adults' performance (May et al., 1999). Younger adults did outperform older adults overall, and Figure 3.7 indicates that younger adults improved more quickly than older adults did. Younger adults improved rapidly at first, but later in the task they did not improve as rapidly as they approached 80% accuracy on Test 3. However, older adults may need to experience a test or two before they start making large gains in accuracy, and thus they did not completely catch up to younger adults' performance.

Pre-task ratings reflected overconfidence, as participants may not have fully understood the difficulty of remembering 18 pairs of items until they actually experienced the task. Perhaps the level difficulty was made clear while studying the first list, or once taking the first test. Post-task ratings were more in line with task performance; the overconfident pre-task ratings were at least affected by the task. Older adults in particular, though still overconfident after the task, did decrease their post-task ratings from their pre-task ratings. By the time the post-task judgment occurred, participants had just completed their fourth cued recall test, on which they scored relatively high after learning throughout the task. Having completed a test on which they scored fairly well might have led to a sense of fluency about the entire memory task (cf. Geraci & Miller, 2013), thus inflating their overall performance judgment to reflect overconfidence rather than estimating how they did on the task overall.

General Discussion

Taken together, the current experiments suggest that a difficult task affects younger and older adults' metacognitive judgments about their and others' abilities to remember medical information. Many patients take several medications simultaneously (Qato et al., 2008), and remembering the side effects of those medications can be important, especially if the presence of a side effect may indicate the presence of a dangerous reaction. However, remembering side effects from multiple medications requires those items to be bound together in memory, which can be difficult for older adults (Naveh-Benjamin, 2000), and could potentially cause memory interference. Highly confident memory errors could lead to harmful consequences, especially when relying on other people to help us remember important information. The current study also allows for a novel investigation of metacognitive judgments about oneself and others.

Our results demonstrate that participants become more accurate in their predictions of performance after the memory task (see Miller & Geraci, 2014), and that both younger and older adults tend to use the midpoint of the scale when rating their performance (Connor et al., 1997). Younger and older adults did not fully account for task difficulty when giving pre-task estimates of performance. The instructions and task construction were different in Experiments 3 and 4, but participants in both experiments estimated that they would correctly recall approximately half of the items before they saw the memory task, perhaps relying on a metacognitive anchor. When one is unsure about task difficulty, it might be reasonable to estimate 50% performance; indeed, anchoring is prevalent when a participant does not know much about the task (Scheck et al., 2004). Overall, younger and older adults' metacognitive judgments were similarly accurate across the task (Halamish et al., 2011; Hertzog & Hultsch, 2000; Rast & Zimprich, 2009), and older adults' post-task ratings in Experiment 3 were in line with performance.

An interesting pattern appears in Experiment 4 when considering the difference among older adults' post-task ratings. While older adults estimated that younger adults would recall about 26% of the items, they expected that a peer of theirs – another adult between the age of 60 and 85 – would remember approximately 47% of the items, a pattern similar previous work on the below-average effect (Kruger, 1999). In Experiment 3, older adults estimated that younger adults would remember more items than another older adult would. Perhaps in Experiment 3, the task was difficult enough that older adults considered it to be a route memorization task, dependent largely upon one's cognitive resources and memory capacity. Perhaps older adult participants in Experiment 4 considered that *interest* in learning the information could be a driving factor in learning: younger adults would remember more items than the older adult personally would remember because younger adults have larger capacities, but an older adult's peer could remember even more information if that person was sufficiently motivated or interested.

In Experiment 3, both age groups remembered real medications more accurately than fictitious medications; in Experiment 4, only older adults showed this pattern. It may be that the difficulty of the memory task in Experiment 3 led participants to rely more on familiarity with the medications or schematic support (cf. Rice & Okun, 1994), while younger adults in Experiment 4 were able to remember side effects associated with both types of medications. Similarly, there were marginal differences in cued recall based on the level of concern associated with the side effect in Experiment 3, but not in Experiment 4, perhaps also related to the difficulty of the task (Hargis & Castel, 2018).

Younger and older adults updated their knowledge about their memory abilities after task experience (Dunlosky & Hertzog, 2000; Touron & Hertzog, 2004; cf. Matvey, Dunlosky, Shaw, Parks, & Hertzog, 2002). In post-task judgments, older participants rated themselves as performing lower than a peer or a medical student. While people often rate themselves as better than average in tasks that are perceived to be easy, the difficulty of the current task likely led in some cases to a below-average effect (note that participants were not asked explicitly to judge "average" performance on this task across all people, but rather individuals from different categories; Kruger, 1999). Future work may ask participants to directly estimate whether they will perform more or less accurately than the average person, and may also incorporate item-by-item JOLs about oneself and others for further investigation of the UWP effect (Finn & Metcalfe, 2008; Tauber & Rhodes, 2012). Additional work may investigate the role of older adults' stereotype threat and anxiety (e.g., Geraci & Miller, 2013) on memory for medical information, and whether these effects may be mediated by metacognition.

In addition to theoretical implications for aging, memory, and metacognition, the current work also has practical implications for the medical field, both in patient care and medical student instruction. Individuals learning medication information may benefit greatly from a quick check of their memory: they can learn the content they do not know *and* learn that their expectations about their memory and others' is often overly optimistic. A short task influenced overconfidence in the current study, but it has yet to be determined what steps can lead to more accurate metacognition about medical information across time and in different learning situations. In summary, the present works suggests that younger and older adults' overconfidence in their cued recall memory for medication information can be adjusted after a difficult learning task, a finding which has implications for metacognition and memory for health-related information across the adult lifespan.

Chapter 3 Conclusions

While social goals are undoubtedly important for older adults, and knowledge-based goals for younger adults, the evidence presented in Chapter 3 suggests that the pursuit of knowledge can be important to both groups – especially when this knowledge is practically valuable. Learning information without an explicit social component is important for both age groups in domains in which health is relevant: Experiments 1 and 2 illustrate that older adults are as accurate as younger adults in their associative recognition of medication interaction outcomes, even when the task was modified to be more difficult by creating interference in memory. There is an even more difficult medication-related task in Experiments 3 and 4, which allows for the examination of high-confidence metacognitive errors: both age groups were largely overconfident in their ability to remember the set of medications and their side effects in Experiment 3, but this overconfidence was affected by a short task that illustrated how difficult learning this information can be. Participants in Experiment 4 also predicted that they would remember approximately 50% of the items presented, as in Experiment 3, which provides interesting evidence for participants' potential reliance on an anchor when making judgments about their memory. Future research can more directly assess whether, how, and why people rely on the midpoint of the scale as an anchor when making global (and/or local) metacognitive judgments.

Experiments 1, 2, 3, and 4 assess memory and metacognition for medical information, which is an important domain across the lifespan as people often (intentionally or unintentionally) do not use medications as prescribed. Overall, evidence presented in Chapter 4 suggests that with repeated study-test cycles, younger and older adults tend to improve their performance with the opportunity to learn from their mistakes if the same information is presented in each trial. However, if that information is confusable – which medication information often is – the picture is not as clear, as participants in both age groups may struggle in particularly difficult tasks. Chapter 4 will investigate how information importance may affect learners’ decisions during study, as well as their accuracy at test.

CHAPTER 4: EFFECT OF IMPORTANCE ON OFFLOADING AND REMEMBERING

When we are not able to remember everything, we often depend on external sources to remember information for us (e.g., Cherkaoui & Gilbert, 2017; Risko & Dunn, 2015; Storm & Stone, 2015). Many of us trust calendar alerts, online to-do lists, and polite emails from colleagues to remind us to go to meetings, finish papers, or meet deadlines. Offloading, or the transfer of the requirements of a task (e.g., remembering a certain piece of information) to an external device rather than one's own cognitive system, is thought to be influenced by our metacognition. More specifically, the decision to offload can be driven by our willingness to exert effort to remember certain information, our perception of our ability to use appropriate strategies, and/or our trust in the system handling the load we give it (Risko & Gilbert, 2016). We may exert effort to remember some information because it is easier or more important to remember than other information; for example, we may not feel as if we need to offload the date of our partner's birthday, as it is a distinctive day that we know we *should* remember. We may know that our ability to use memory strategies can be compromised if we have too much to remember: for example, we may offload a list of 15 items to purchase at the grocery store but not a list of five items. Also, we may offload more content to a system that is likely to be there when we need it: to extend the grocery store example, we may choose an application on our omnipresent phones to record our grocery list rather than using a paper list that we run the risk of leaving at home.

With the advent of digital offloading mechanisms, we can supplement our paper-and-pencil offloading – or replace it completely – with smartphone applications and cloud-based software. Those who once used a written to-do list may now opt for an omnipresent, ultra-convenient electronic to-do list (which is also perhaps less susceptible to poor legibility from rushed handwriting). Hamilton and Benjamin (2019) discuss how we use technology as an external memory source by arguing that the relationship between human memory and technological memory can be thought of as an "extended organism" that can do more than the sum of its parts. That is, the limitations of human memory and of technology by themselves are in some ways improved upon when those two work together (e.g., a human may be limited by an imperfect memory, while a technological device such as the internet may be limited by lack of creativity to combine multiple related areas of knowledge). In the current study, our primary goal is to assess how individuals choose to offload, and whether those decisions affect memory. However, we do use a paradigm that, due to it being a computer program, may be more similar to offloading to a smartphone app than to a paper-and-pencil system.

Saving some information, or at least setting it aside, gives us the opportunity to reallocate cognitive resources toward other information. Prior work suggests that instructing participants that an initial list of items can be forgotten can enhance memory for other, to-be-learned items (Bjork & Woodward, 1973). Other work provides evidence for a preserved recency effect for words that participants were instructed to forget (Lee, 2013). Similar dynamics could be at play in the current study as the saving mechanism may serve as a type of self-directed forgetting, such that participants may try to forget saved information in favor of remembering that which has not been saved.

While offloading can include writing information on paper, many of us use technology as a memory aid by using to-do list applications, digital calendars, or email reminders. The way we interact with technology is of interest in the current study, particularly how we may need to make judgments about our reliance on technology using a sort of extended metacognition. Much of the metacognitive literature asks participants how they feel about their own memory abilities in the moment (e.g., item-by-item judgments of learning; Hertzog, Dunlosky, Robinson, & Kidder, 2003; Koriat, Sheffer, & Ma'ayan, 2002) and over time (e.g., the stability of memory; Kornell and Bjork, 2009), or sometimes how we feel about another person's memory abilities (e.g., Nickerson, 1999; see also Chapter 3, Experiments 3 and 4).

However, we often need to make metacognitive judgments about technology: how much am I relying on this technological tool to help me remember? What would my memory performance be like without this tool? For example, using a car's GPS to get to a new location may seem like a fluent experience, but people may not be aware of how much they rely on this external device – if they try to return home without the GPS, people may overestimate the strength of their memory trace for the directions and find it difficult to return without an external aid. When a student studies using notes that they will not be able to use during the exam, they also may not have an accurate representation of their own memory abilities. This inaccurate representation may cause them to study less effectively than they otherwise would if they did not have help from an external source. That is, we may not take into account the ubiquity and helpfulness of memory aids, particularly as they are available via technology, when assessing our own memory abilities.

Previous work suggests that technology does influence our thinking during a memory task. Sparrow, Liu, and Wegner (2011) found that difficult memory questions made participants think more about computers, perhaps because they may often use computers to answer questions they cannot answer themselves (e.g., "Google, what are the primary side effects of Namenda?"). The use of computers to find and save information can allow us the opportunity to use those cognitive resources on other tasks, but it may not be without cost, as saving valuable information to an untrustworthy or unreliable source, for example, could have uncomfortable consequences.

If my doctor advised me to remember important medication dosage information, and I saved that information to a digital source only to find later that it had not properly been stored, I would likely regret using that opportunity to offload and wish that I had either committed to exerting effort to use an appropriate memory strategy or that I had offloaded onto a more trustworthy source (e.g., a notebook).

There is, in fact, a benefit to memory for saved information, but only when the information is saved to a reliable source. Storm and Stone (2015) presented participants with lists of words in PDF files. The first of the PDF files that participants studied was either saved or not saved to the computer, but whether the first studied file would be saved was not made clear to the participant until after the study session for that file was complete. When participants were able to save the first studied file, their recall accuracy for the words presented in the second file was higher than if they had not been able to save the first file, thus illustrating what Storm and Stone (2015) argue to be a saving-enhanced memory effect. If the saved source was unreliable, this effect was extinguished. This prior work provides evidence that saving a set of information can benefit the learning of new information, in line with the directed forgetting literature described above (Bjork & Woodward, 1973).

In contrast with Storm and Stone (2015), the current experiments allow participants to make their own saving decisions. We examine how these saving decisions may affect later memory, as measured by both recall tests and a surprise recognition test. In Experiment 1, participants studied words only; in Experiment 2, participants were presented with an adapted value-directed remembering paradigm (Castel, 2008), in which they studied words that varied with respect to their value.

When participants are able to save words to the computer, the first question of interest is whether they trust the saving mechanism enough to do so. Secondarily, does the act of choosing words to offload thus make them more distinctive to the participant? Previous work (Hunt & Worthen, 2006) suggests that memory is improved for items made distinct, in a perceptual sense or in a semantic sense. If the offloaded words are particularly salient to the participants since they were chosen for saving, they might later intrude in the participants' recall, and a participant may be unsure whether the remembered word was already saved. The surprise recognition test will also assess whether offloaded words remain in memory. If offloading acts as an effective instruction to forget, participants are not expected to recognize offloaded words at a high rate during a surprise final test. If, however, the offloaded words are still available, participants should recognize them during the final test.

Experiment 1

The purpose of Experiment 1 was to assess whether and how participants used the offloading system, whether they recalled offloaded words, and whether they recognized words they had offloaded and/or recalled during a surprise final test. Participants were given multiple opportunities to learn how the offloading mechanism works and what strategies were effective, as they studied eight lists of words, each followed by a recall test. Participants were not told about the final recognition test until after the eighth recall test.

Method

Participants

A total of 28 undergraduate students at the University of California, Los Angeles participated in this study for partial course credit. Participants ranged in age from 18-26 (M = 20.61, SD = 1.97); 24 were female, three were male, and one other.

Materials and Procedure

A total of 240 unique nouns were presented to each participant. To reduce the likelihood of specific item effects, these words were randomly drawn from a bank of 400 nouns that ranged from four to six letters in length. The words in the bank averaged 8.73 (*SD* = 1.81) on the log-transformed Hyperspace Analogue to Language (HAL) frequency scale (Balota et al., 2007). Participants were told that they would be completing a memory task in which they would be presented with 30 words. After studying all 30 words simultaneously, participants would complete a free recall test in which they were asked to recall as many words from the preceding list as they could. There were a total of eight study-test cycles, each with unique words, and there was a feedback portion after each free recall test in which participants were told how many words they and the computer recalled correctly (e.g., “You recalled (and the computer saved) 18 of 30 words”).

Critically, participants were also told that during the study sessions, which were to last 90s each, they would be able to save six words to the computer by clicking on them (see Figures 4.1a and 4.1b for example study screens). When participants clicked on the word they wished to save, it appeared in a box below the study area and was underlined within the study area so that participants could keep track of which word(s) they had saved. If participants attempted to save more than six words, the computer alerted them that this was not possible, and they were able to “un-save” words by clicking them again to remove them from the “saved words” box at the bottom of the screen (see Figure 4.1b). There was also a timer on the screen that counted down the remaining seconds that participants had to study the words. Participants repeated this study test-trial for a total of eight cycles. After the final recall test, participants were presented with a recognition test. They were presented with the full list of 400 words and asked to check a box next to each word they remembered seeing on the task (each participant saw a total of 240 of the words, but the amount of words they could check during this test was not limited).

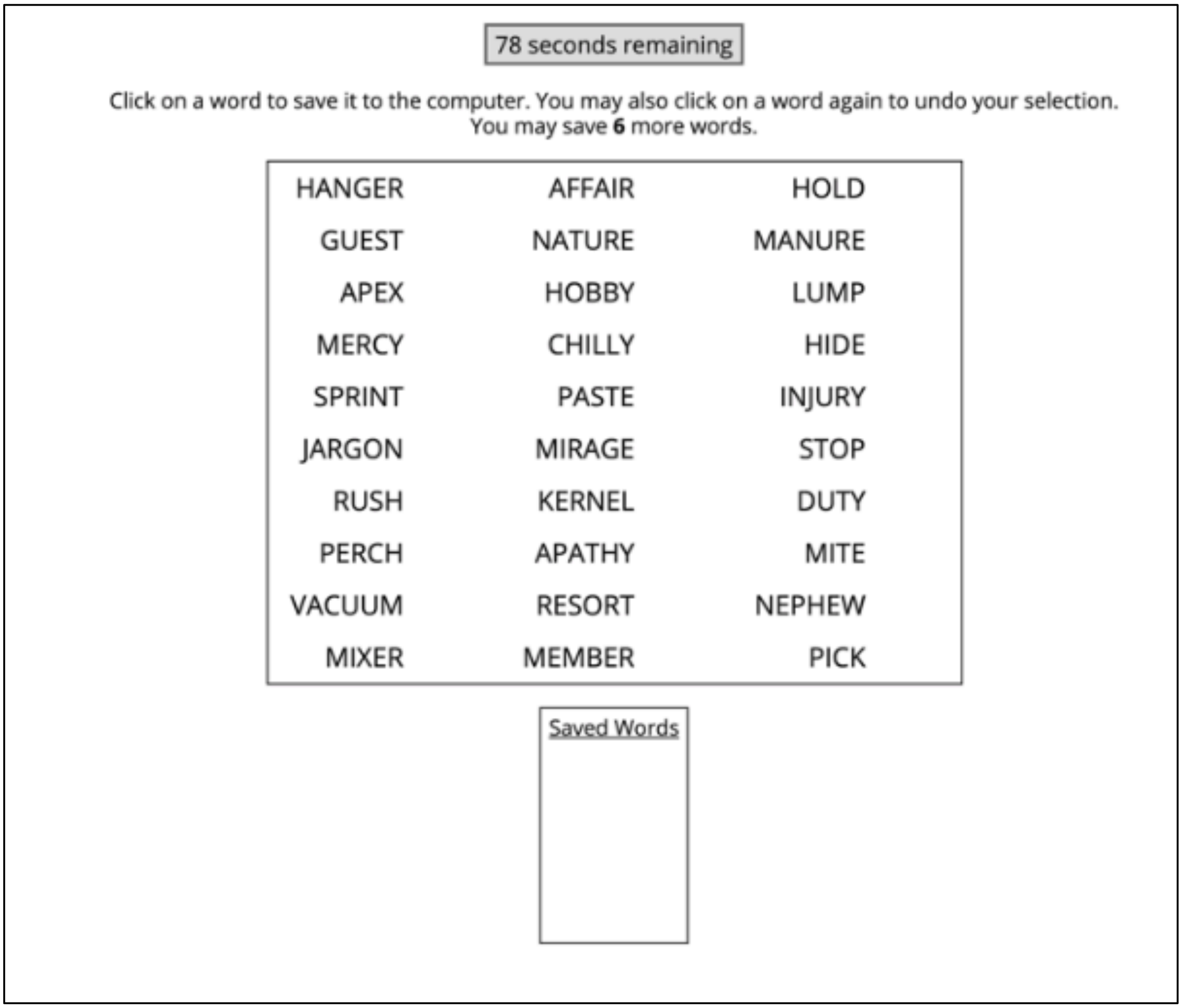

Figure 4.1a. An example study trial in Experiment 1. A timer counts down from 90s, 30 words are displayed, and there is a box in which saved words will appear after participants click on them.

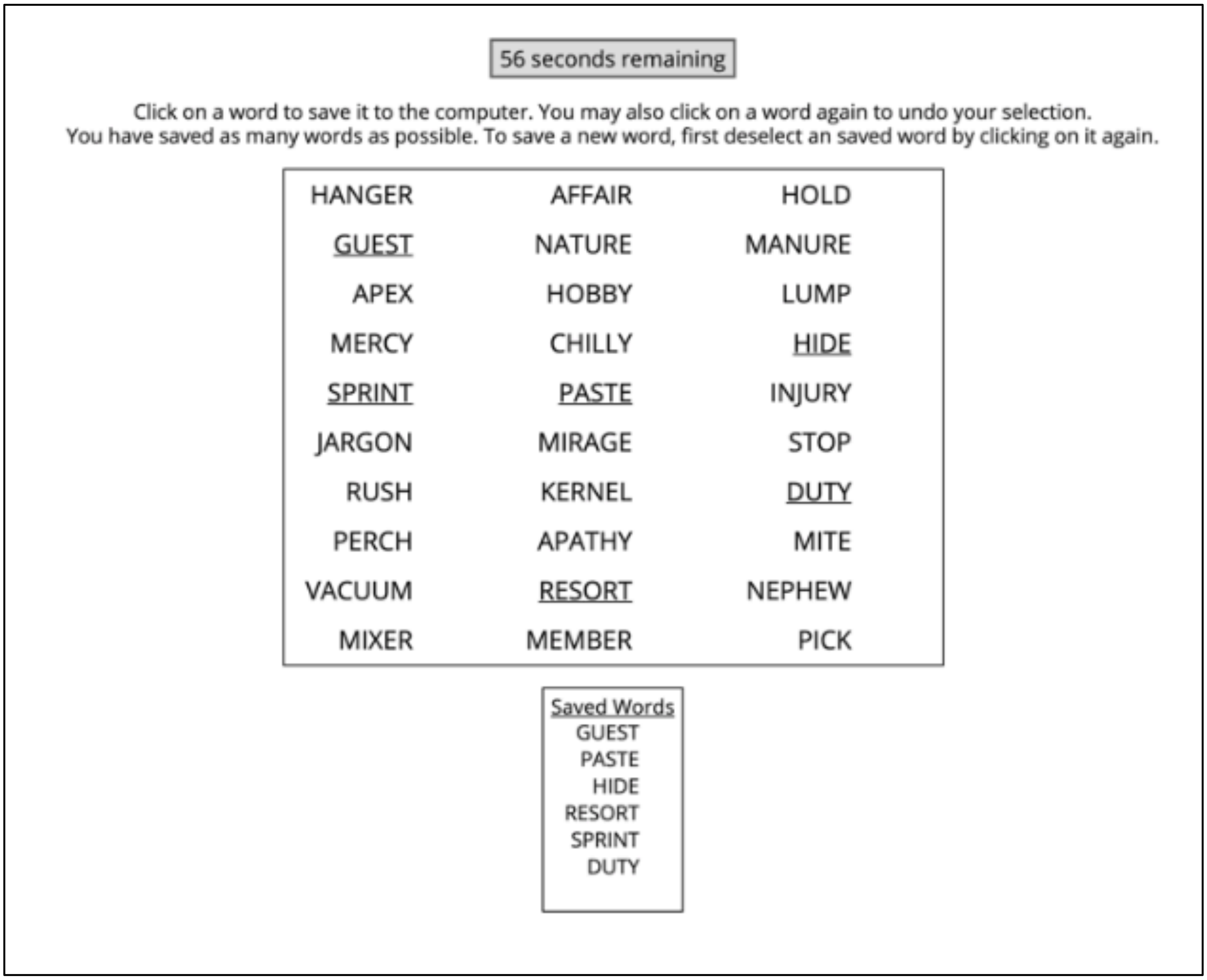

Figure 4.1b. An example study trial in Experiment 1 with words saved. This figure presents the same study trial as in Figure 4.1a, but with six words saved (saved words are underlined in the study box and are also included in the box below).

Results

Offloading and recall

To determine whether participants began the task by offloading fewer words — perhaps due to a lack of trust in the computer, or a reflection of overconfidence in which one would not need to rely on the computer — we conducted a one-way analysis of variance (ANOVA). The amount of words offloaded did not change significantly across the task, $F(7, 315) = 1.86$, $p = .08$, as many participants offloaded the maximum six words on every trial ($M = 5.80$, $SD = 0.81$).

To determine whether participants' performance on the task (as measured by the amount of words they correctly recalled) increased with task experience (perhaps due to a better understanding of how the offloading system worked), a one-way ANOVA was conducted. In line with prior work, the amount of words recalled also did not change across the task — that is, there was no difference in the number of words participants correctly recalled across the eight test trials, $F(7, 189) = 1.53$, $p = .16$, $\eta^2 = .05$, see Figure 4.2. Participants were presented with new words on each list, so the potential for accumulated learning was not present, and the potential for interference and confusability from prior trials was possible.

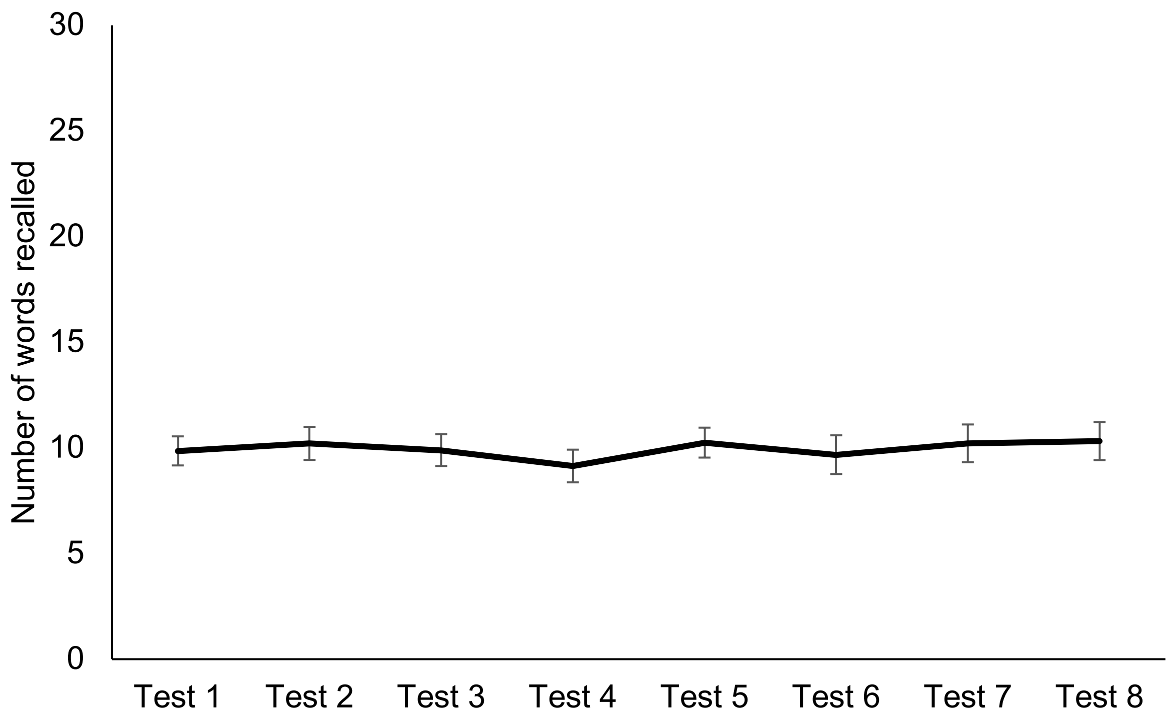

Figure 4.2. The number of words recalled across the task in Experiment 1 (not including offloaded words). Error bars represent standard error.

Recognition

Figure 4.3 suggests that the best-recognized words were those that had been recalled on previous lists, but also that words that were offloaded were not completely forgotten. A one-way ANOVA revealed that there were differences in recognition accuracy among words that were recalled, were not recalled, and were offloaded, $F(2, 54) = 27.00$, $p < .001$, $\eta^2 = .50$. Words that had been recalled were recognized more accurately than those that were offloaded, $t(27) = 7.11$, $p < .001$, and more accurately than those that were not recalled, $t(27) = 6.43$, $p < .001$. There was no difference in recognition accuracy among words that were offloaded and words that were not recalled, $t(27) =1.47$, $p = .15$. On average, participants falsely recognized 10.43 words (SD = 11.48).

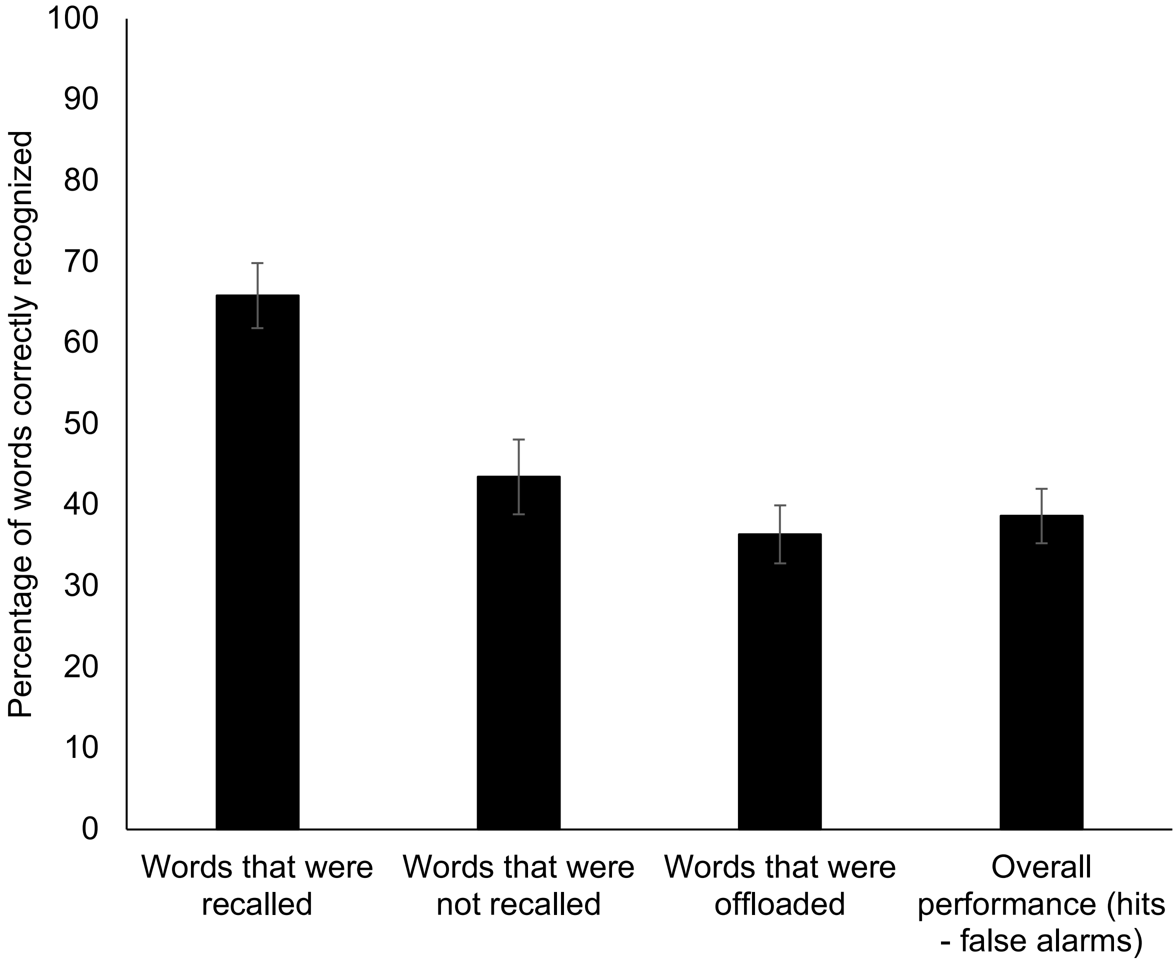

Figure 4.3. The percentage of words correctly recognized in Experiment 1. The percentage of words correctly recognized in Experiment 1 differed based on whether those words were recalled during the task, not recalled during the task, or offloaded during study as compared to overall performance on the recognition test. Error bars represent standard error.

To further investigate how recalling a word during the task was related to its likelihood of later being recognized, we conducted a one-way ANOVA (see Figure 4.4). This test allows us to examine how a word that was recalled early on in the task may be less likely to be recognized than a word that was recalled later in the task. The ANOVA revealed a main effect of list, F(7,

189) = 2.14, p = .03, η^2 = .07, such that there were changes in how many of the words recalled on each test were later recognized. We conducted post-hoc t-tests to assess where the differences lie, but no tests reached significance following the Bonferroni correction for multiple comparisons (the comparison that was closest to reaching statistical significance was between Test 4 (M = 5.79, SD = 4.63) and Test 8 (M = 8.14, SD = 5.14), t(27) = 3.03, p = .006, all other ps > .05.

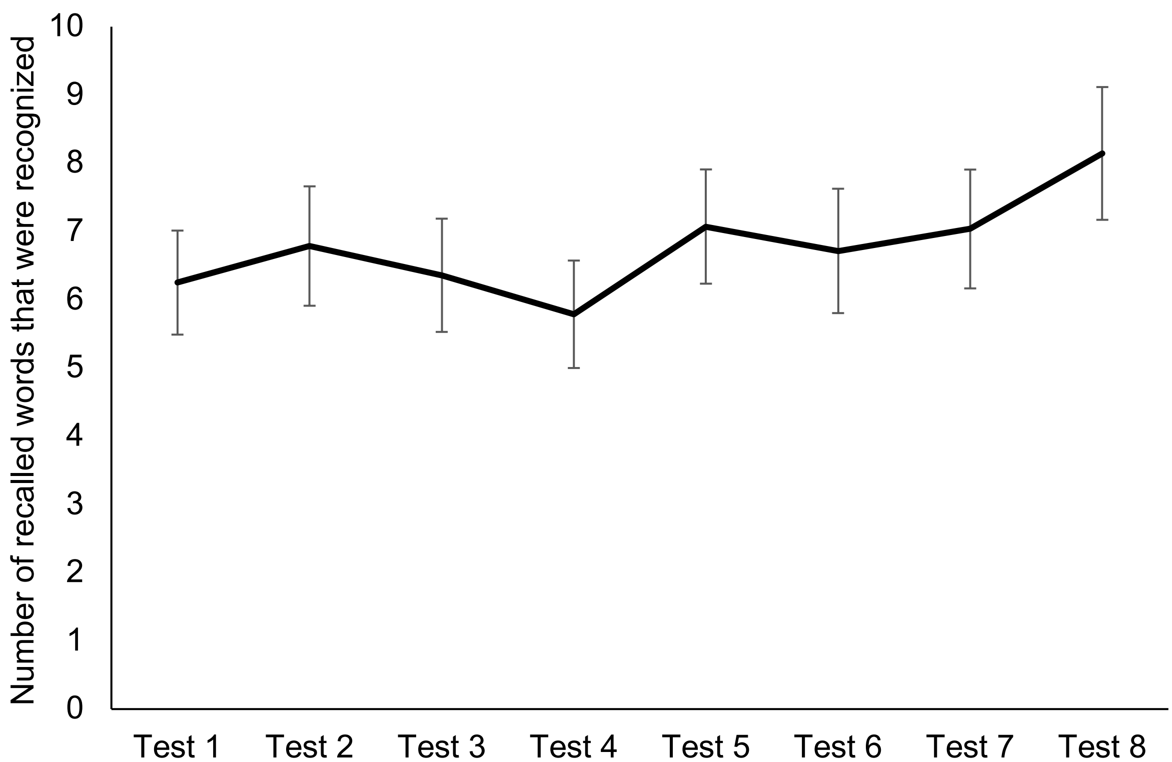

Figure 4.4. The number of words on each list that were recalled during Experiment 1 that were *also* correctly recognized at the very end of the task during the surprise recognition test. Participants studied 30 words on each list. Error bars represent standard error.

At the end of the task, participants rated their trust that the computer would remember their saved words: *M* = 88.32, *SD* = 23.65 (on a scale from 0 to 100, with 0 meaning not at all and 100 meaning completely).

Discussion

In the current study, participants were faced with two decisions: how much information should I save to the computer (if any), and, if I do choose to save information, what kind of information should that be? For the most part, participants chose to save, or offload, the maximum amount of words to the computer (participants were told that the computer's storage capacity was six words). That is, people took full advantage of the saving mechanism. Participants recalled approximately 10 words per list on the free-recall tests, which did not change significantly across the task.

Participants recognized the words they recalled at a fairly high rate during the final surprise recognition test. While participants recognized words that they offloaded slightly less accurately than they recognized words they recalled (and equally as accurately as words they did not recall), they did not completely forget offloaded words. Words that were offloaded were recognized at a higher rate (M = 16.64 words per list, SD = 8.93) than false-alarm recognitions of words that did not appear during study (M = 10.43 words per list, SD = 11.48), $t(27) = 2.59$, p = .02 (see Bjork & Woodward, 1973; Davis & Okada, 1971). The final recognition test included 480 words, 240 of which participants had seen before (they were "old" words), so the false alarm rate was relatively low. That is, on average, participants incorrectly said 4.35% of "new" words were words they had seen before.

Experiment 2

In Experiment 1, participants' goal was to remember as many words as possible. They did not have specific direction about which words to prioritize, or even indirect suggestions about which words to offload. In Experiment 2, participants' goal was no longer simply to remember as many words as possible, but to maximize their score, which was calculated by summing the points associated with the words participants offloaded and recalled on each list. The introduction of value into an experiment assessing offloading decisions and memory performance allows us to examine how those processes are affected when some information becomes more important than other information (which can reflect real-life situations, such as when offloading and remembering critical ingredients for a recipe or important concepts for an exam).

If participants trust the saving mechanism to remember the words for them more than they trust their own memory abilities, they should offload the maximum amount of words, while making sure that those words are of the highest value. If the participants do not feel the need to take advantage of the option to save words to the computer, they may rely on their own memory instead to recall the highest-value items. Overall, we predict that value will affect both recall and offloading decisions, as well as performance on the surprise final recognition test.

Method

Participants

A total of 28 undergraduate students at the University of California, Los Angeles participated in this study for course credit, ranging in age from 18-25 (*M* = 20.68, *SD* = 1.83); 26 were female. None had participated in Experiment 1.

Materials and Procedure

The materials were identical to Experiment 1. The procedure was similar, except for the added value component: each word was randomly paired with a point value ranging from 1 to 30. In the initial task instructions, participants were told that their goal was to maximize their score (their score was calculated by adding up the points associated with the words they recalled – they did not have to recall the point values, only the words). Participants were able to save up to six words to the computer. The computer noted a running calculation of the total point value of the words saved inside the box (e.g., "current value: 165"), so participants were aware of how many points they would receive at test when the computer recalled these words on their behalf (see Figures 4.5a and 4.5b for example study screens). As in Experiment 1, there were eight study-test trials with new words on each list. When participants moved on to the free recall test immediately after the 90s study session, they were also told the number of points they occurred due to the computer saving the words they selected (e.g., "Points from words saved by the computer: 165"). Feedback was given after each test in the form of points earned by the participant and by the computer (i.e., how many points participants earned from the offloaded words).

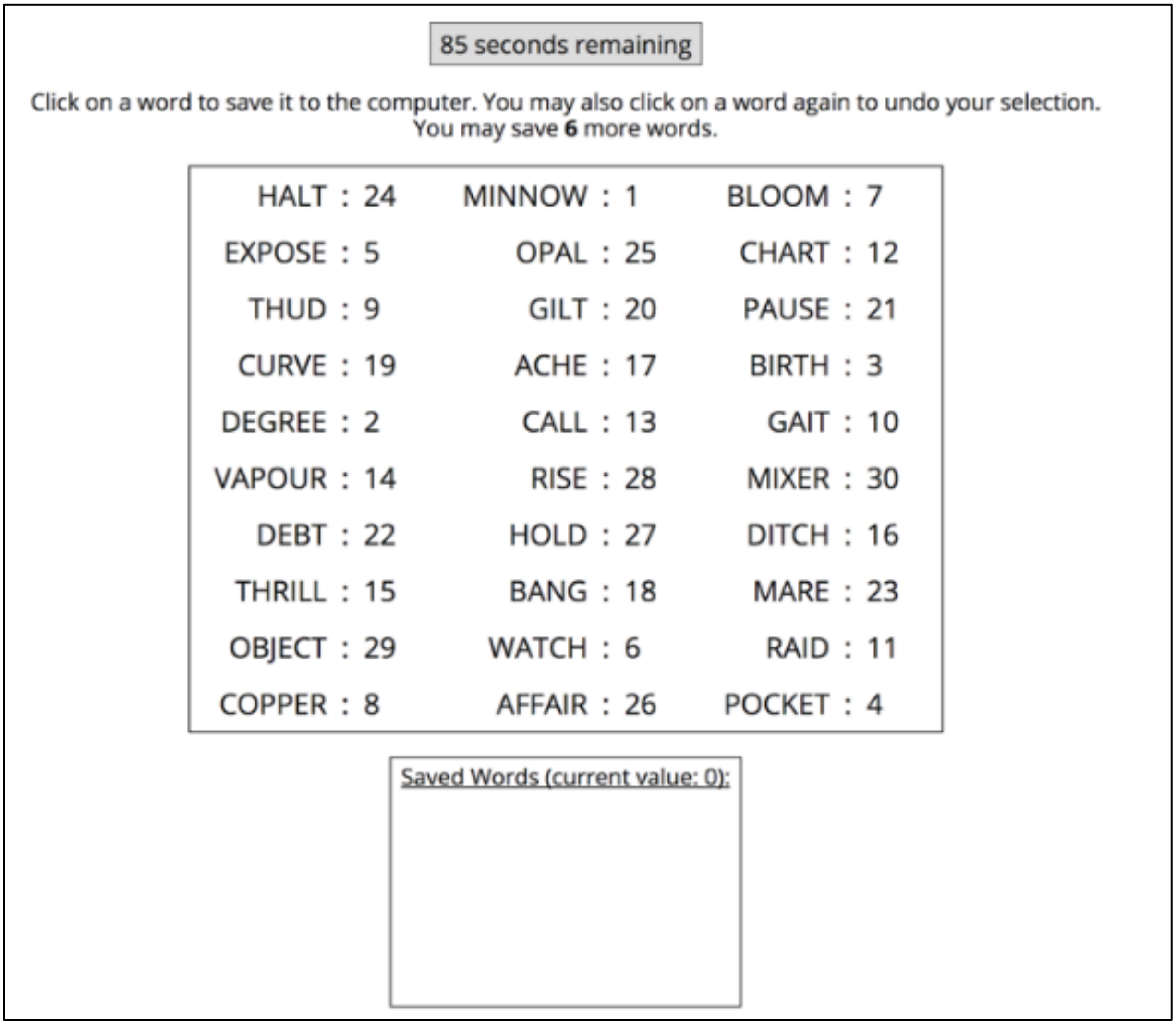

Figure 4.5a. A study trial from Experiment 2. A timer counts down from 90s, 30 words are displayed with corresponding point values, and there is a box in which saved words will appear after participants click on them.

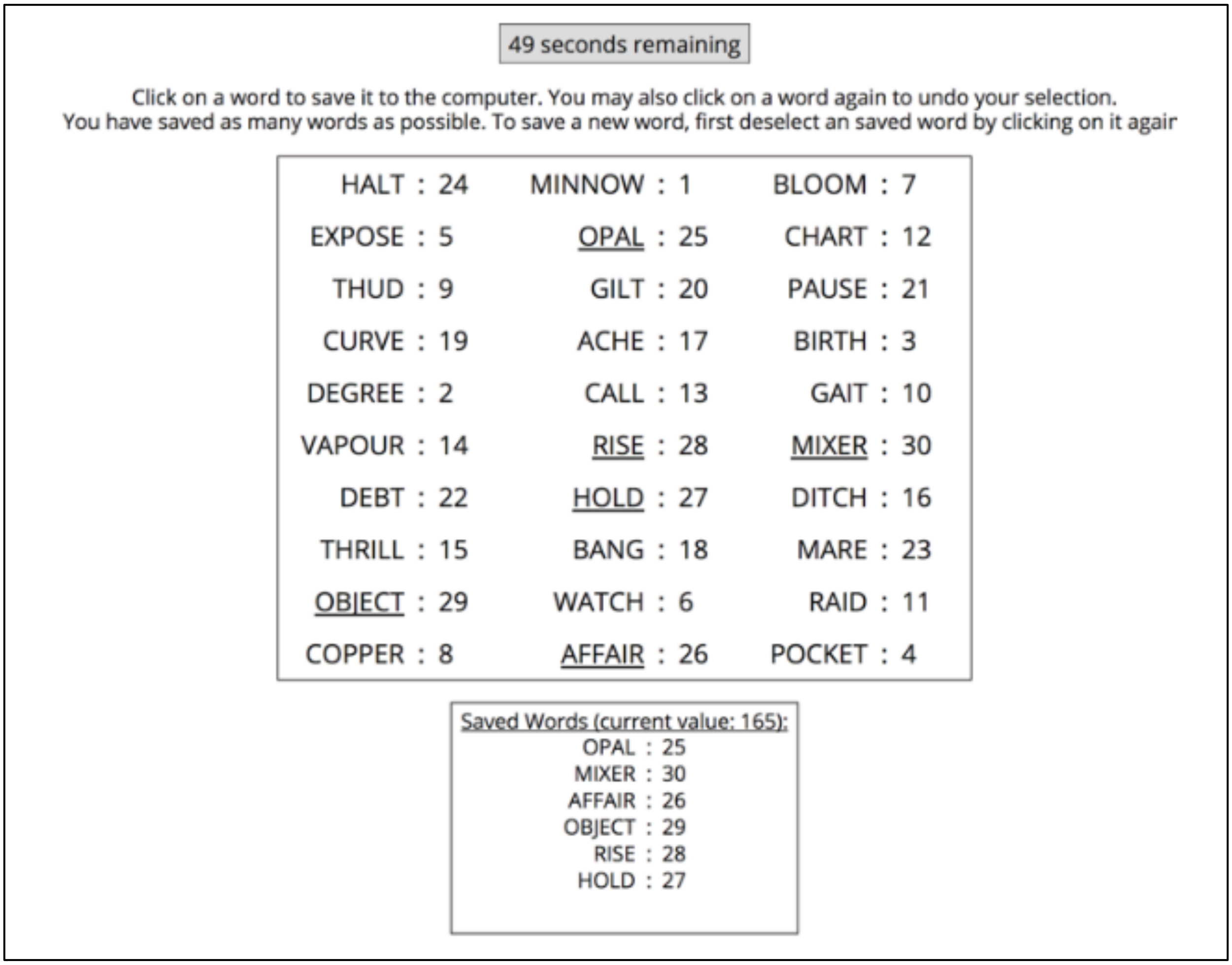

Figure 4.5b. A study trial from Experiment 2 with words saved. This figure presents the same study trial as in Figure 4.5a, but with six high-value words saved (saved words are underlined in the study box and are also included in the box below).

Results

Offloading and recall

As in Experiment 1, the amount of words recalled did not change across the task, $F(7, 203) = 0.68$, $p = .69$, $\eta^2 = .02$, see Figure 4.6.

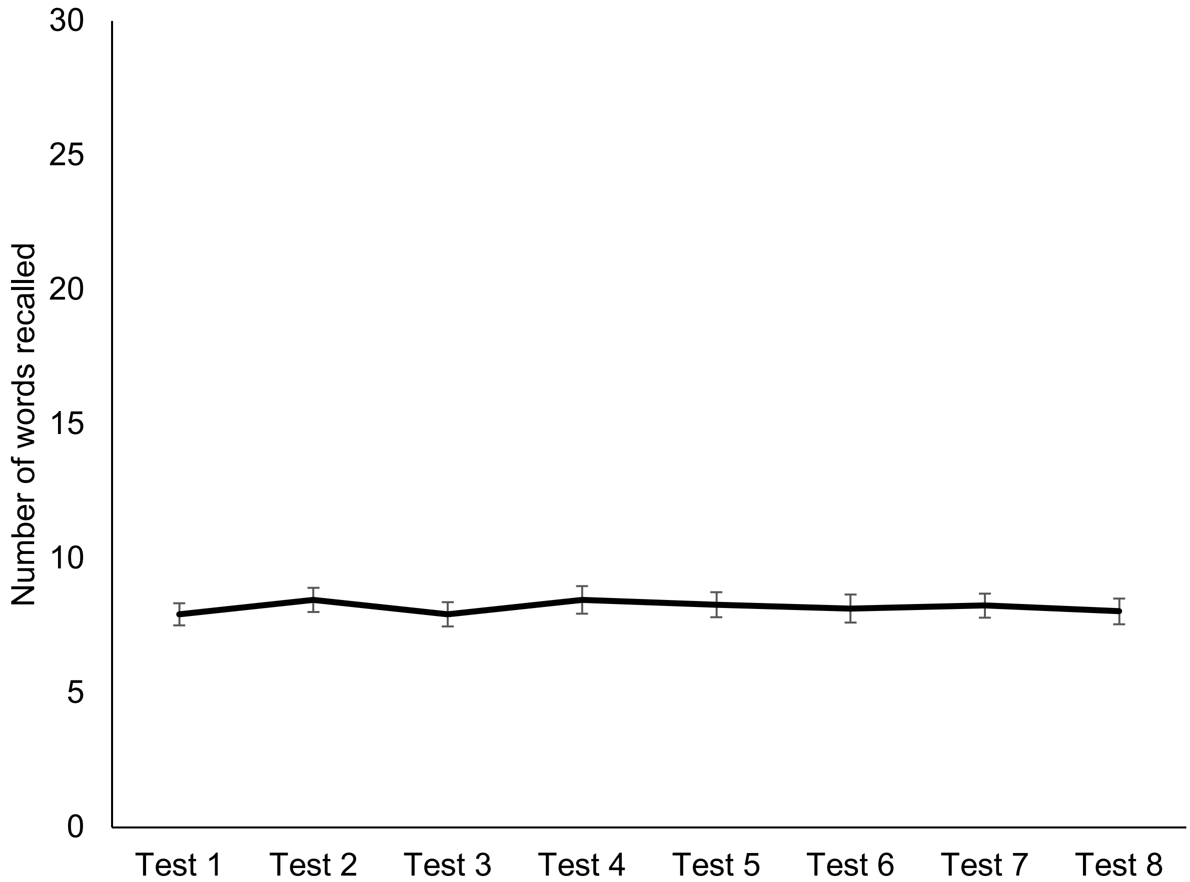

Figure 4.6. The number of words recalled across the task in Experiment 2 (not including offloaded words). Error bars represent standard error.

Also similarly to Experiment 1, out of six possible words that participants were able to offload, participants very commonly chose to offload all six words (across eight lists, $M = 5.97$, $SD = 0.41$). There was no difference across list of the amount of words participants chose to recall, $F(7, 189) = 1.34$, $p = .23$, $\eta^2 = .05$. If participants were to offload the six most valuable words on a given list (30 + 29 + 28 + 27 + 26 + 25), their average offloaded value for that list would be 27.5. Most participants offloaded the most valuable words throughout the task.

Selectivity index (SI) was calculated for both the offloaded words and the recalled words to determine to what extent participants were selective in their offloading and in their recall (see

Figure 4.7). There was a main effect of list on the selectivity index of the offloaded words, $F(7, 189) = 3.42$, $p < .01$, $\eta^2 = .11$, as participants became more selective with the words they offloaded across the task. We conducted post-hoc *t*-tests to assess where the differences lie, but no tests reached significance following the Bonferroni correction for multiple comparisons (the comparison that was closest to reaching statistical significance was between List 1 ($M = 0.52$, $SD = 0.35$) and List 7 ($M = 0.71$, $SD = 0.25$), $t(27) = 3.32$, $p = .003$, all other *p*s > .05.

In contrast, a one-way ANOVA revealed no main effect of list on the selectivity index of words that were recalled, $F(7, 189) = 1.25$, $p = .28$, $\eta^2 = .04$, such that participants' recall selectivity (as measured by SI) did not increase across the task.

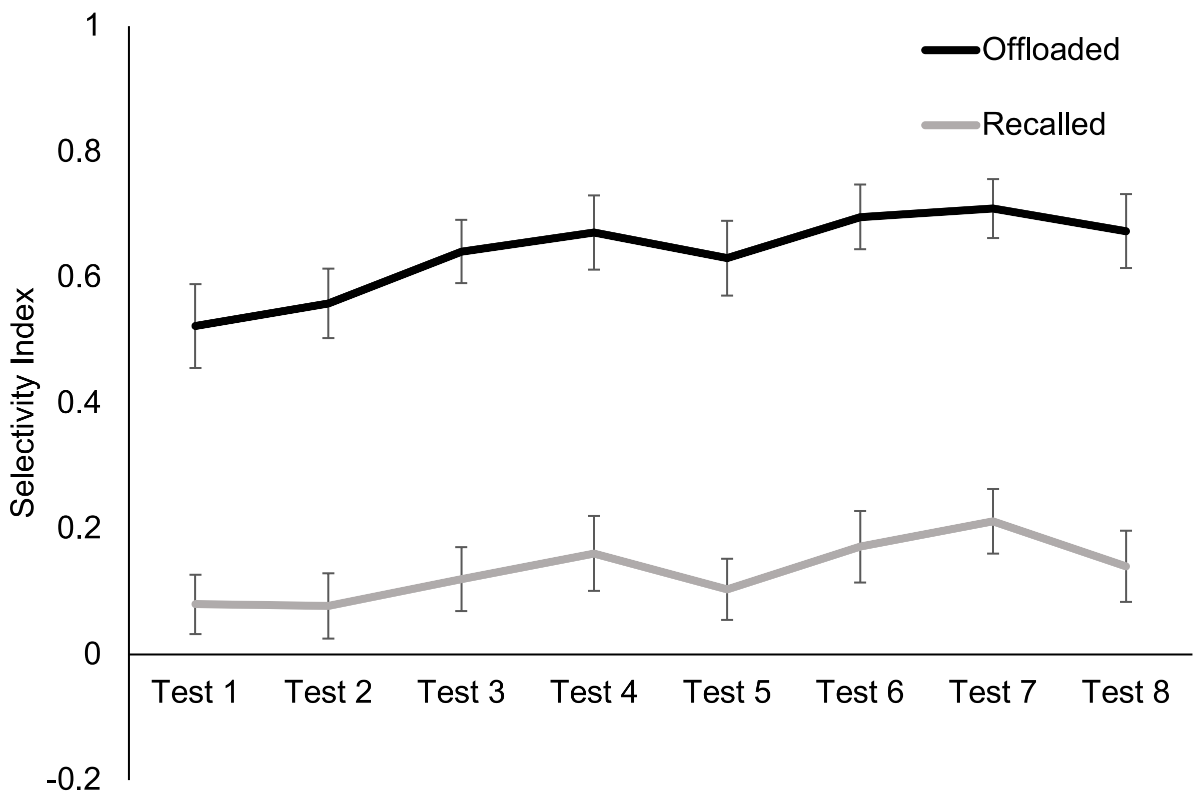

Figure 4.7. The extent to which participants prioritized high-value words (as measured by selectivity index) across Experiment 2, both in their offloading decisions (black line) and recall performance (gray line). Error bars represent standard error.

Further, we sought to examine whether the offloaded words were of higher value than the recalled words (see Figure 4.8), and whether such a pattern may have changed across the task. To do this, we conducted a 2(words: offloaded, recalled) x 8(list) within-subjects ANOVA. There was no two-way interaction between whether a word was offloaded or recalled and list, $F(7, 196) = 0.70$, $p = .68$, $\eta^2 = .02$, nor was there a significant main effect of list, $F(7,196) = 1.88$, $p = .07$, $\eta^2 = .06$. There was, however, a significant main effect when comparing the value of words that were offloaded and words that were recalled, $F(1, 28) = 235.17$, $p < .001$, $\eta^2 = .89$, such that offloaded words were of a significantly higher value than words that were recalled ($M = 25.99$, $SD = 3.21$, and $M = 16.92$, $SD = 3.11$, respectively).

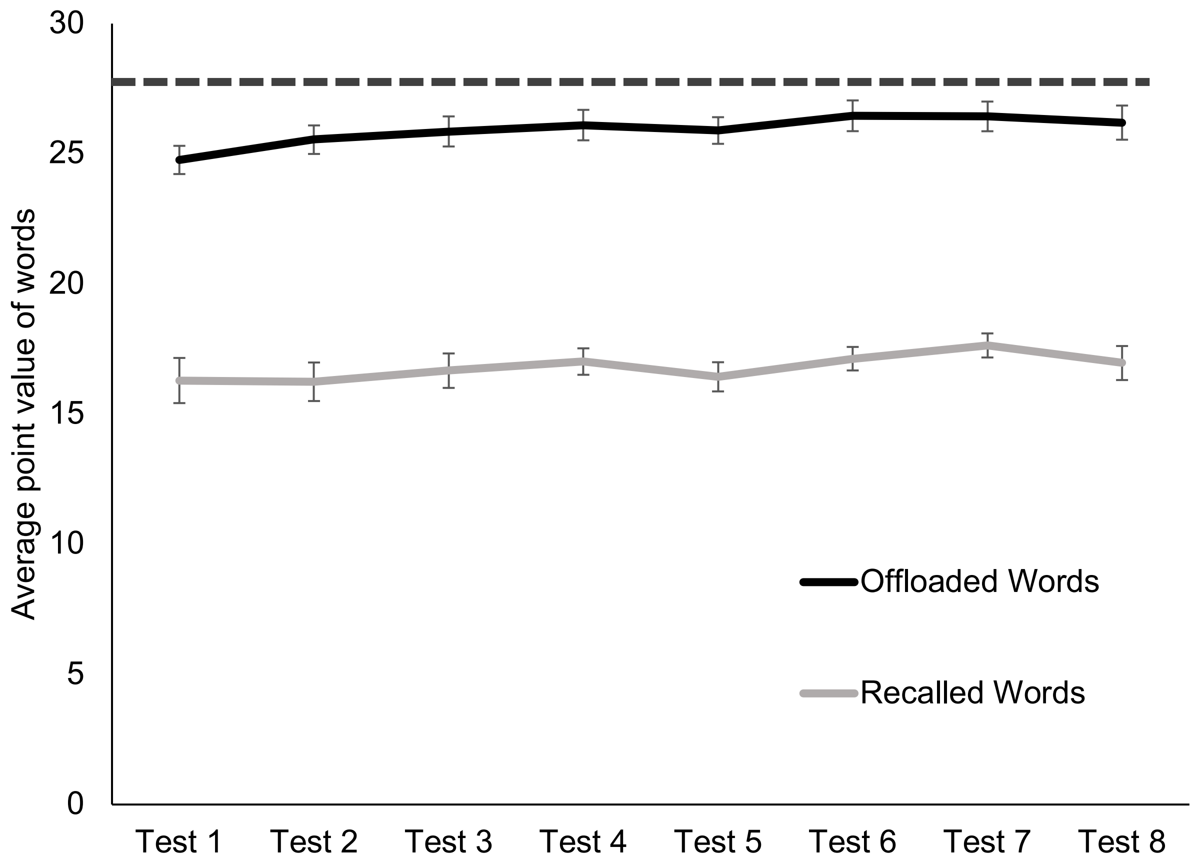

Figure 4.8. The average point value of words that were offloaded (black line) and recalled (gray line) across the task in Experiment 2. The dashed line at 27.5 points represents the average of the top six most valuable words (i.e., the average value of words with 30, 29, 28, 27, 26, and 25 points). Error bars represent standard error.

Across the task, few words were both offloaded and recalled. On average, participants offloaded and recalled fewer than one word per list (M = 0.62, SD = 1.60), or an average of 4.96 words across the task (SD = 12.14; mode = 0). Though offloading and recalling the same word was uncommon, of the words that were offloaded and recalled, the average point value was 24.08 points (SD = 4.91).

Recognition

As in Experiment 1, Figure 4.9 suggests that the best-recognized words were those that had been recalled on previous lists. It also suggests that offloaded words were not completely forgotten. A one-way ANOVA revealed that there were differences in recognition accuracy among words that were recalled, were not recalled, and were offloaded, $F(2, 54) = 94.60$, $p < .001$, $\eta^2 = .78$. Words that had been recalled were recognized more accurately than those that were offloaded, $t(27) = 9.09$, $p < .001$, and more accurately than those that were not recalled, $t(27) = 12.53$, $p < .001$. There was no difference in recognition accuracy among words that were offloaded and words that were not recalled, $t(27) = 0.70$, $p = .49$. On average, participants falsely recognized 12.75 words ($SD = 15.92$) on the final test. Because the final recognition test included 480 words, 240 of which participants had seen before, this reflects a relatively low false alarm rate (that is, on average, participants incorrectly said 5.31% of "new" words were words they had seen before).

Figure 4.10 illustrates how many words on each list were both recalled during the task and recognized correctly at the end of the task. Unlike in Experiment 1, there was no main effect of list, $F(7, 189) = 1.21$, $p = .30$, $\eta^2 = .04$. Also unlike Experiment 1, words that were offloaded were not recognized at a higher rate than false-alarm recognitions of words that did not appear during study, $t(27) = 1.29$, $p = .21$. When asked at the end of the task how much they trusted the computer on a scale from 0 to 100, with 0 meaning not at all and 100 meaning completely, participants gave an average rating of 92.00 ($SD = 21.38$).

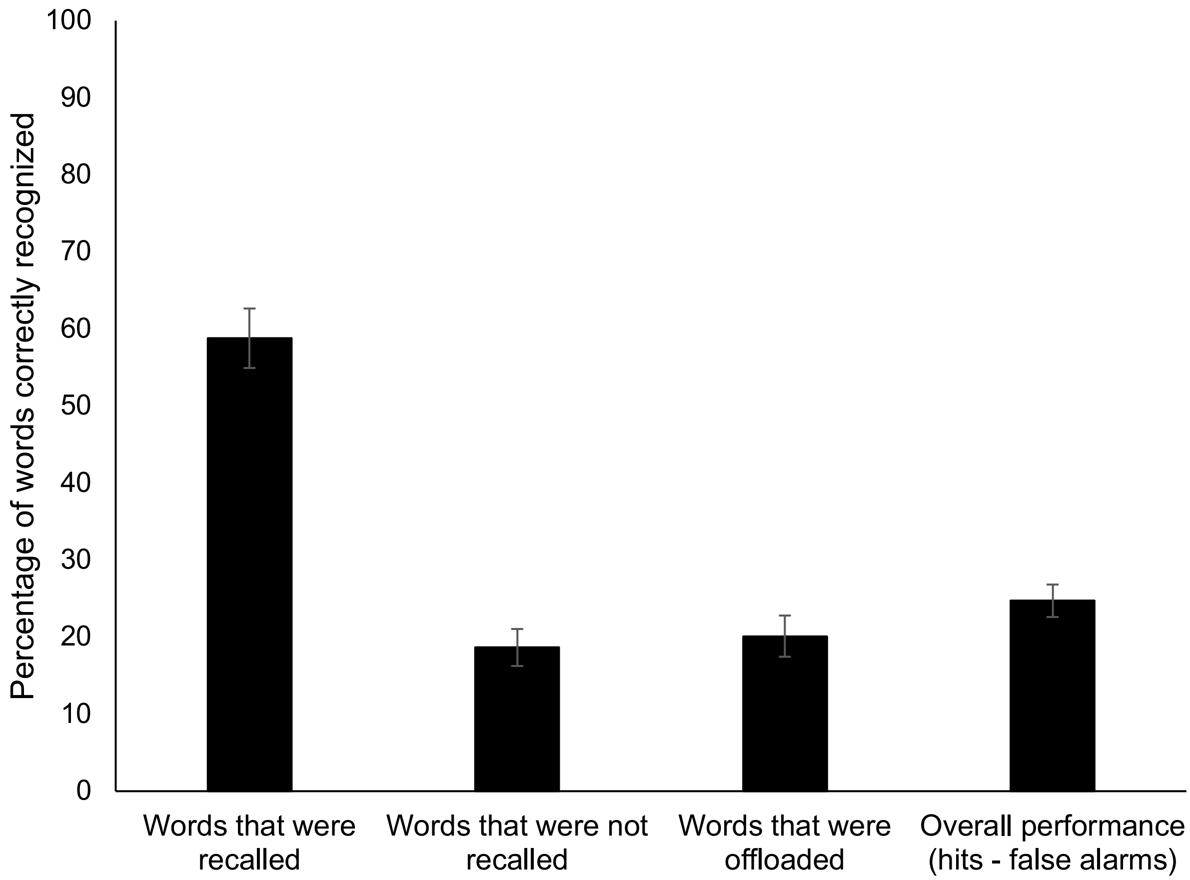

Figure 4.9. The percentage of words correctly recognized in Experiment 2. The percentage of words correctly recognized in Experiment 2 differed based on whether those words were recalled during the task, not recalled during the task, or offloaded during study as compared to overall performance on the recognition test. Error bars represent standard error.

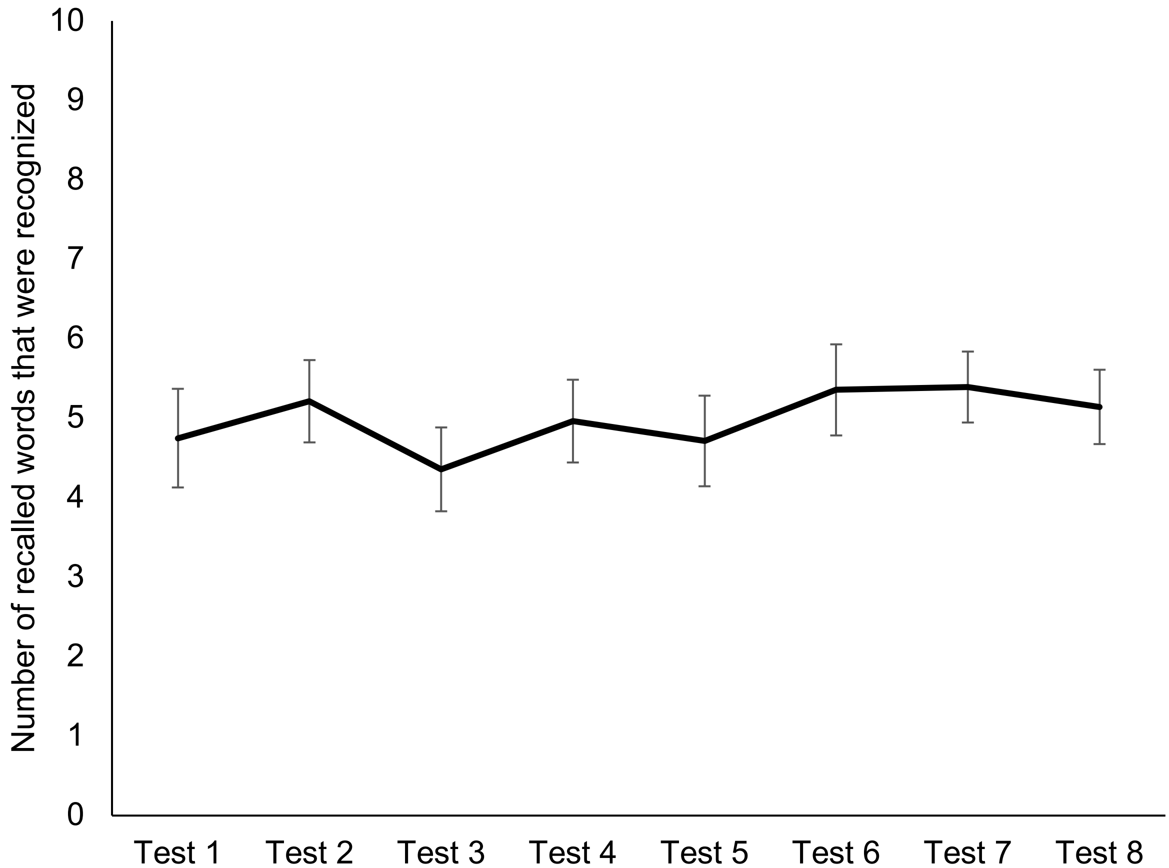

Figure 4.10. The number of words on each list that were recalled during Experiment 2 that were *also* correctly recognized at the very end of the task during the surprise recognition test. Participants studied 30 words on each list. Error bars represent standard error.

We also sought to determine whether value was related to performance on the final recognition test. Figure 4.11 illustrates the proportion of words of each point value that were offloaded during study, as well as the proportion of words of each point value that were correctly recognized on the final test. The gray line representing offloading is low and relatively stable until words of approximately 20 points, and reflects a substantial increase between the values of 24 and 25, supporting the notion that participants offloaded the highest value items. In contrast, the black line indicating recognition accuracy slopes upward (i.e., higher-value items are remembered more accurately) until the six highest-value items, which are recognized at a rate comparable to the lowest-value items.

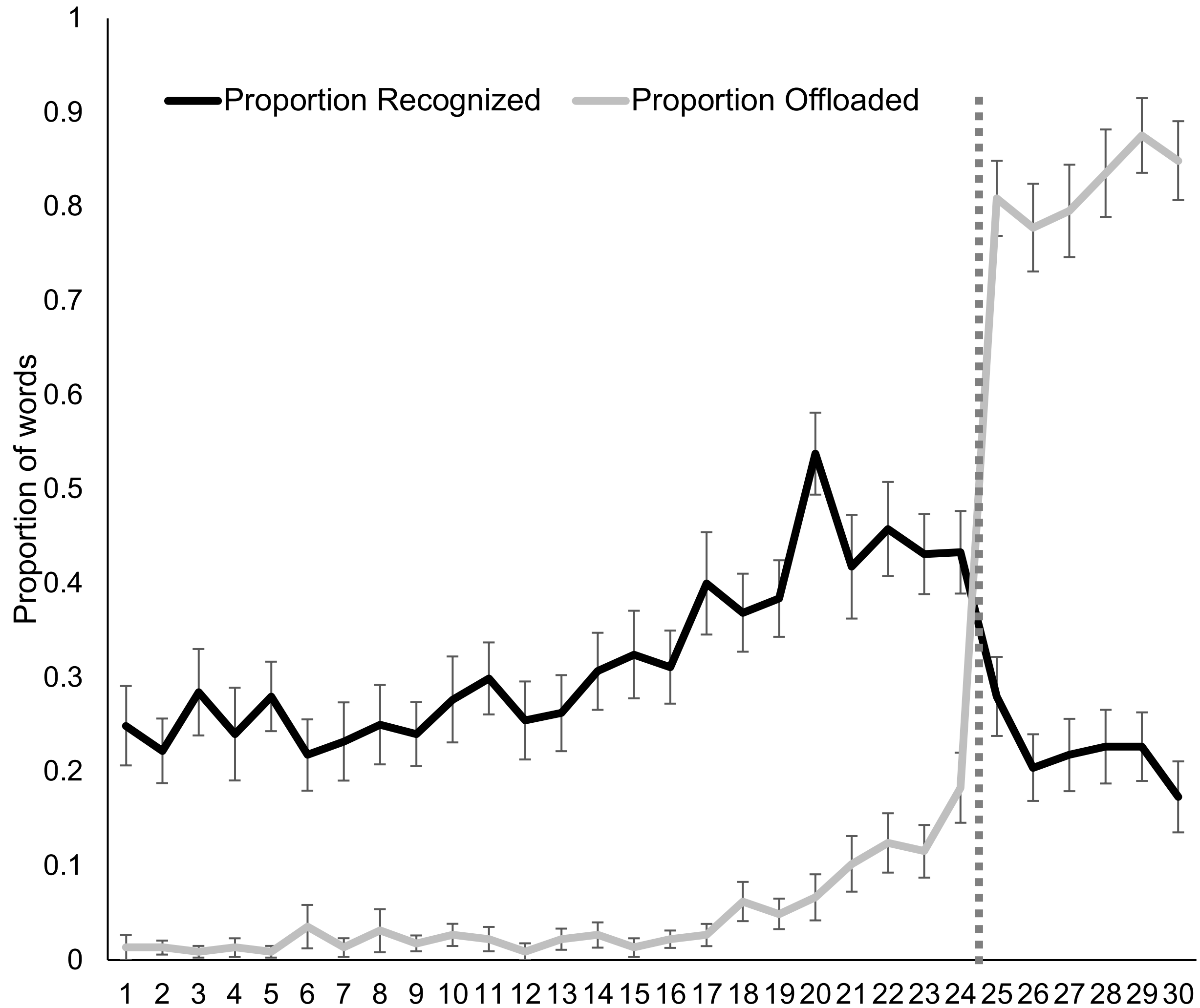

Figure 4.11. The proportion of words of each point value in Experiment 2 that were offloaded during study (gray line) and correctly recognized on the final test (black line). To the right of the dashed line is the offloading proportion and recognition accuracy for the six highest-value items. Error bars represent standard error.

We also assessed the point values of the words that were correctly recognized and compared them to the point values of words that participants studied but were not correctly recognized. We conducted a paired-samples *t*-test to assess whether the average point values differed, which did reveal a significant difference, $t(27) = 2.44$, $p = .02$, such that words that were correctly recognized on the final recognition test were of higher value than those that were not correctly recognized ($M = 16.46$, $SD = 1.79$, and $M = 15.32$, $SD = 0.83$, respectively).

Discussion

Across the task, the selectivity index of the offloaded words increased, suggesting that participants were using those six "save" slots more wisely with task experience by directing the computer to remember the most valuable words. This could reflect an increase in trust in the computer to reliably recall the saved words across the task. The increase in selectivity index of the offloaded words across the task could also reflect an increasing awareness of one's limited memory capacity (e.g., it is difficult to remember these valuable words, and the computer is more dependable than my memory capacity is). There was no difference in the amount of words recalled across the list, which is consistent with Experiment 1 and with prior work (e.g., Castel, 2008).

It is possible that an increase in high-value offloaded words while there was no increase in the selectivity index of words recalled is due to offloading more high value words while also remembering more lower-value words (in a sense, replacing the high-value words that would have taken up memory capacity with low value words, because there is perceived "room" to do so). A tendency to recall the same amount of words overall across the task, but with an increasing proportion of low-value words, would be captured by a decrease in selectivity index across the task. In fact, analyses revealed no significant difference in selectivity index of recalled words across the eight test trials, suggesting that participants were equally selective in their recall across the task (though they were more selective in their offloading across the task, as discussed above). It is perhaps an optimal strategy to offload words with lower value at first, while one acclimates to the task, before depending on the computer to remember the highest-value words. Once the computer is determined to be trustworthy and participants understand more about their capacity limitations, more valuable words are offloaded. As in Experiment 1, participants commonly saved the maximum of six words per trial. In Experiment 2, participants also commonly offloaded high-value words. In sum, participants in both Experiments took advantage of the saving mechanism to its fullest extent.

In contrast with Experiment 1, words that were offloaded in Experiment 2 were recognized equally as often as false-alarm recognitions of words that did not appear during study, which does not provide evidence that offloaded words were learned during study. As illustrated in Figure 4.11, recognition accuracy is sensitive to value: higher-value items are remembered more accurately than lower-value items except for the six highest-value items, which are recognized at a rate comparable to the items on the lowest end of the value spectrum. This finding is of particular interest: the decision to offload high-value items was effective during the free recall portion of the experiment. However, it seems that especially in Experiment 2, the offloading of high-value information did act as an effective cue to forget that information.

General Discussion

The current study utilized a novel paradigm to examine how, when presented with more words than they can hope to remember, participants saved valuable information to the computer. We sought to examine how offloading words might affect recall and recognition, and whether value influenced decisions and performance. In both Experiemnts, participants relied on the offloading mechanism that can be considered as an “extended organism” (Hamilton & Benjamin, 2019, p. 40) to remember words for them, and the effects of this saving on memory differed between the two Experiments. The number of words recalled did not differ across the task in either experiment, and few participants offloaded and recalled the same words, but recognition accuracy was affected by the value of the to-be-learned information.

Directed forgetting (Bjork & Woodward, 1973) involves the designation of some information as to-be-forgotten, and some information as to-be-remembered. In the current study, participants may have used the “saving” option during study as a type of self-directed forgetting: they decided what should be remembered and what should be effectively forgotten (as only a few participants recalled offloaded words on only a handful of trials throughout the entire task). There may be a benefit to memory for saved information (Storm & Stone, 2015), but participants do not often spontaneously recall saved information — the current study allowed participants to recall those words but did not explicitly ask them to do so. The findings of the current study mirror the real-life situation of participants saving items to a virtual to-do list; once the information is saved to the to do-list, it is not spontaneously recalled again (as long as the program tasked with doing the remembering can be trusted to remember than information).

In Experiment 1, the results of the final recognition tests suggest that the offloaded words are not completely forgotten; that is, if there is a self-directed forgetting cue for the offloaded words, it does not completely erase them from memory. In contrast, in Experiment 2, the offloaded words do appear to be effectively forgotten (i.e., the recognition rates of offloaded words did not differ from false alarms to lures that were not studied; Bjork & Woodward, 1973). This argument is supported by data illustrated in Figure 4.11, which displays recognition performance by point value. Participants usually offloaded the six highest-value words (see

Figure 4.8, which compares the values of offloaded and recalled words across Experiment 2), and those words were often forgotten by the recognition test (in which recognition accuracy was similar to that of the lowest-value items). The self-directed forgetting of the high-value information was particularly potent.

This difference between Experiments 1 and 2 may be due to participants' having an explicit strategy or goal in their offloading in Experiment 2, but not in Experiment 1. That is, in Experiment 1, there is no surface-level information (e.g., point value) to guide participants when they are making their offloading: they may consider several words to offload, think about their likelihood of remembering those later, and then choose to offload them or not. In contrast, in Experiment 2, it is obvious what participants should do, given that they trust the offloading mechanism: they should offload the words associated with the highest point values. If participants use that strategy, they do not need to consider any characteristic of the word beyond its value; indeed, participants need not even look at the actual word they are offloading, only use its point value to guide their decision. Then, once those top-value words are offloaded, participants devote more time to remembering higher-value items, which is reflected in their recall performance as well as in their final recognition performance (i.e., the value curve on Figure 4.18 from points 1 to 24).

Participants in Experiments 1 and 2 differ in their performance accuracy on the recall and recognition tests, as illustrated in Figures 4.2 and 4.6 (recall) and Figures 4.3 and 4.9 (recognition). When comparing accuracy on the recall tests across lists and between experiments, there is a main effect of experiment, $F(1, 54) = 5.82$, $p = .02$, $\eta^2 = .10$, such that participants in Experiment 1 ($M = 9.95$ words per list, $SD = 4.21$) performed better than participants in Experiment 2 ($M = 8.19$ words per list, $SD = 2.45$) did. (In this analysis, there was no main effect of list, $F(7, 378) = 0.45$, $p = .87$, $\eta^2 = .01$, nor was there an interaction between list and experiment, $F(7, 378) = 0.61$, $p = .75$, $\eta^2 = .01$.) On the recognition test, there was a two-way interaction between experiment and how a word was treated in the study-recall phase of the task (offloaded, recalled, or not recalled), $F(2, 108) = 5.55$, $p = .01$, $\eta^2 = .04$. Post-hoc independent-samples t-tests revealed that participants in Experiment 1 performed more accurately in recognizing the words they had offloaded than those in Experiment 2, $t(54) = 3.65$, $p < .001$ (with accuracy proportions of $M = 0.36$, $SD = 0.19$ and $M = 0.20$, $SD = 0.14$, respectively), and participants in Experiment 1 recognized words that were not recalled during the task more accurately than those in Experiment 2, $t(54) = 4.77$, $p < .001$ ($M = 0.44$, $SD = .24$ and $M = 0.19$, $SD = 0.13$, respectively). There was not a statistically significant difference in how accurately participants in Experiments 1 and 2 recognized the words they recalled during the task, $t(54) = 1.27$, $p = .21$.

One candidate explanation for these between-experiment differences in accuracy is the time participants spent on the memory tests. Participants were able to spend as much time as they wished on these tests and advance to the next phase of the experiment whenever they chose. Time spent on these tests, especially the recognition test, could be considered a proxy for effort on the tests – though, of course, this is an imperfect comparison. Nevertheless, we compared how much time participants in Experiments 1 and 2 spent on the recall tests (Figure 4.12) and the recognition test (Figure 4.13). Figure 4.12 suggests that overall, participants in Experiment 1 did spend slightly more time on the recall tests compared to those in Experiment 2; this difference was not statistically significant, $F(1, 54) = 3.27$, $p = .09$, $\eta^2 = .06$. (There was also no interaction between experiment and list, $F(7, 378) = 1.00$, $p = .43$, $\eta^2 = .02$. There was a main effect of list, $F(7, 378) = 12.92$, $p < .001$, $\eta^2 = .19$, and follow-up *t*-tests revealed this was driven by time spent on Test 1 being longer than time spent on all other tests, *p*s < .05). The differences in time spent on the recognition task are also interesting: participants spent 15 fewer seconds, on average, in Experiment 2, though this difference also failed to reach statistical significance, $t(54) = 0.52$, $p = .61$.

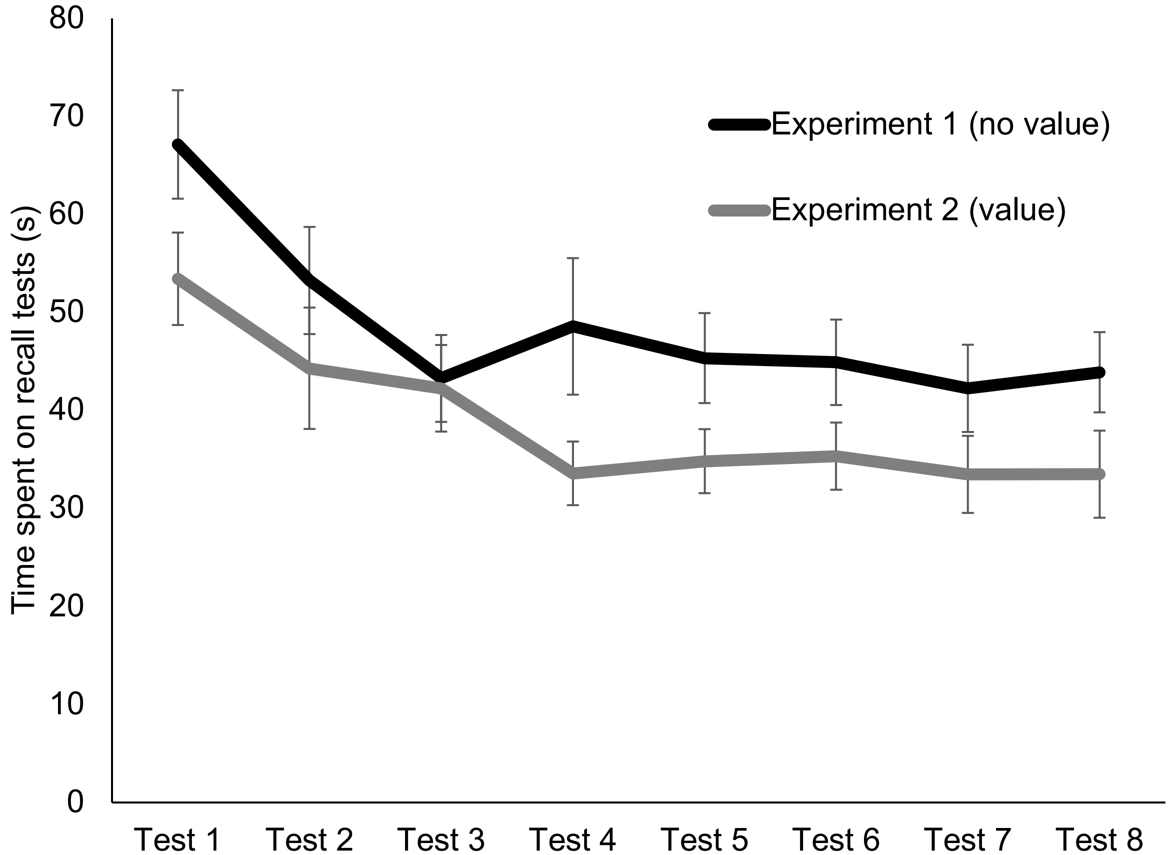

Figure 4.12. The average time in seconds participants spent on each recall test during Experiments 1 and 2. Error bars represent standard error.

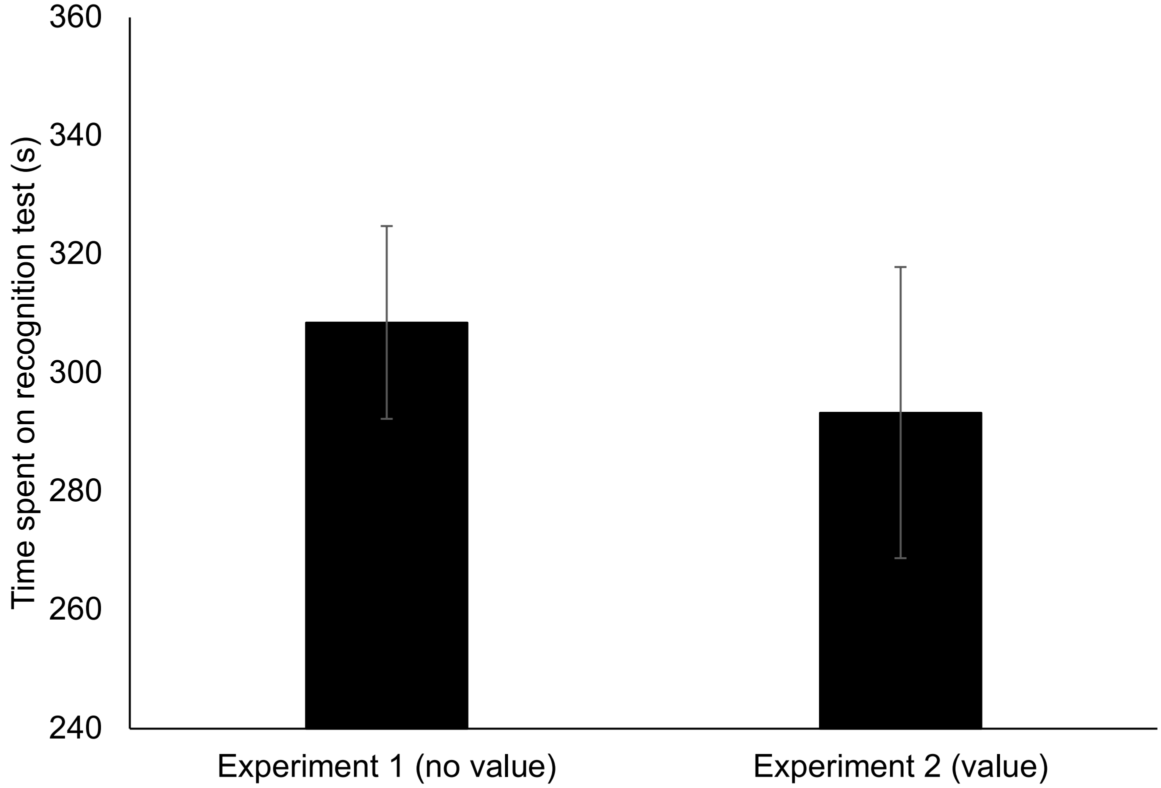

Figure 4.13. The average time in seconds (240 s = 4 min, 360 s = 6 min) participants spent on the final recognition test during Experiments 1 and 2. Error bars represent standard error.

Chapter 4 Conclusions

In Chapter 4, I sought to assess how offloading may affect recall and recognition, and how value may affect how people choose what to save and remember. We often offload important information to external sources, such as to-do lists, grocery lists, and flash cards or study guides. The findings reported in Experiments 1 and 2 suggest that when participants are able to save information to a trustworthy source, they take full advantage of that ability, maximizing the amount (Experiments 1 and 2) and value (Experiment 2) of the saved words, rather than relying on their own abilities to remember important information. In Experiment 1, participants did not completely forget offloaded words; in Experiment 2, the self-directed forgetting was powerful enough that offloaded words were recognized at a rate equivalent to lures that had not been presented during study.

Differences between Experiments 1 and 2 are not likely to be fully attributable to differences in how much time participants spent on each test. We propose that one or more other factors contribute to between-experiment differences: for example, participants in Experiment 2 had a more complex goal than those in Experiment 1, which might have required more cognitive resources during study to pursue (thus leaving them with less cognitive capacity to study the words). More specifically, those in Experiment 2 were not only trying to offload words and study words, but were also paying attention to another variable (the words' point values) and how that variable could help them achieve their goal of maximizing their score. In Experiment 1, participants did not need to exert extra attention to any value structure, which may explain why they remembered more information on the recall tests.

More broadly speaking, the amount of deliberation involved in the offloading decision process affected later incidental memory performance. When there was a substantial amount of deliberation, or thoughtfulness, about whether to offload a given item, those items were encoded more strongly and were therefore later recognized. Because participants did not expect a recognition test, this recognition memory for offloaded items can be considered incidental rather than explicitly purposeful. In contrast, when there was not much deliberation about whether to offload a given item (e.g., for the high value items in Experiment 2), that item was not later recognized.

Participants in the Experiments 1 and 2 trusted the offloading mechanism to work in their favor. Future work in which the computer's reliability is manipulated by telling participants after the test that the computer made an "error" that resulted in their saved words being lost would allow for examination of whether participants still decided to offload valuable information, even if the source was unreliable (cf. Storm & Stone, 2015), and whether they also recall the information that they offloaded just in case the computer fails. Additionally, future work can investigate how other characteristics of the words besides value (e.g., concreteness, frequency) may influence offloading decisions to assess whether the difficulty of learning a word influences its likelihood of being offloaded.

In sum, Chapter 4 provides a novel investigation of extended cognition and metacognition (e.g., see Hamilton & Benjamin, 2019), offloading and self-directed forgetting, and how important information in particular is susceptible to forgetting if we feel that we have stored it somewhere reliable.

CHAPTER 5: GENERAL CONCLUSIONS AND FUTURE DIRECTIONS

Overview of findings

Prior work suggests that older adults are largely driven by the urge to connect to others socially, while younger adults' strongest motivating factor is the desire to acquire knowledge. However, there are meaningful instances in which older adults seek to learn, either to achieve an external goal (e.g., Bye et al., 2007), or for the sake of learning (Wolfgang & Dowling, 1981), or perhaps both. Younger and older adults often have different goals, but instances in which they overlap are worth examining, particularly in the domain of memory. If a subset of information is important to the participant, he or she is likely more motivated to remember it than unimportant information, and therefore age-related memory deficits for important information can be reduced (or absent). Motivation to learn can thus have a powerful impact on memory across the adult lifespan. The notion that being motivated to remember information improves performance is tested in the current Dissertation using novel stimuli, including social information, foreign language word pairs, and medication interactions, while considering the predictions of prior work such as socioemotional selectivity theory (Charles & Carstensen, 2010; Carstensen & Charles, 1998; Carstensen, Fung, & Charles, 2003; Ersner-Hershfield et al., 2008; Fredrickson & Carstensen, 1990; Fung, Carstensen, & Lutz, 1999).

The research reported in Chapters 2, 3, and 4 addresses questions regarding younger and older adults' motivation to remember in relatively practical contexts: when learning information about other people, when learning information to use when communicating with other people, and when learning health-related information. Through the lens of socioemotional selectivity theory (Carstensen et al., 1999), I examined how older age might affect memory for information about social partners or for information that may be relayed to another person. I then widened the scope of goal pursuit in learning to include how older adults remember medication interactions and side effects in light of possible age-related deficits in memory for associative information (Naveh-Benjamin, 2000) before investigating how offloading and value can affect younger learners' performance on recall and recognition tests.

Younger and older adults' memory for important social information

In Chapter 2, participants learned associative social information of varying value. Overall, older adults can struggle in these associative tasks, as binding pairs of unrelated information (e.g., a person's face and their arbitrarily-assigned name) can be difficult in healthy aging. Additionally, peoples' names are often more difficult to learn than other biographical information about them, such as their hobbies or occupations, and remembering people's names is a common memory complaint among older adults in particular.

In Experiment 1, participants studied triads of social information: a person's face, their name, and their occupation. These triads varied with respect to the likelihood that the participant would need to use that information in the future. Recall was sensitive to likelihood of future use; younger and older adults recalled important associative social information (name-occupation pairs) equally accurately. As is a pattern throughout this Dissertation, participants' performance improved across study-test trials as they had an opportunity to learn more information with task experience. Experiment 1 provides evidence for the benefit of repeated testing and restudy opportunities for both age groups (though younger adults did consistently outperform older adults in recalling information that was less important, which is consistent with prior work). In Experiment 2, younger participants were allowed only 1s to study each item (compared with 3s each in Experiment 1) in order to reduce the processing resources younger adults could bring to bear during the encoding phase. In this task, both age groups prioritized information that was most important throughout the task; although younger adults had less time to encode than older adults did, they were able to selectively remember the information that had a high likelihood of future use. Additionally, older adults (and, to some extent, younger adults) remembered people's occupations more accurately than they remembered names, which is in line with prior work suggesting that biographical information that is *not* name information is easier to learn than names are. Taken together, Experiments 1 and 2 provide evidence that younger and older adults can use effective memory strategies to remember important associative information about others.

Study 3 (in Chapter 2) builds upon the notion that names are more difficult to remember than other types of biographical information. Given that older people often comment that their memory for names is "not what it used to be," and even younger adults may lament that they are "bad with names," Study 3 examines whether metacognitive judgments are in line with this awareness that remembering names is difficult. Evidence in support of such awareness includes a potential spotlight effect: it can be embarrassing when we forget others' names, and this embarrassment may make our failure come to mind more easily when we are asked to make judgments about our abilities. Further, participants across the adult lifespan, but especially older adults, may experience tip-of-the-tongue states when trying to recall names, further increasing the salience of prior mistakes. Even so, substantial prior work has established than we often rate ourselves as better than the average person in many domains, including social qualities like leadership ability. There is thus some conflict between two hypotheses: do we see ourselves as better than average at remembering all types of information, or are we sensitive to our struggle to remember names? Study 3 supports the latter point: both younger and older participants rate themselves as no different from the average person their age in their ability to remember others' names. Participants in both age groups did rate themselves as better than average in other domains such as honesty, capacity for hard work, and leadership ability, as well as their overall memory accuracy, suggesting that people are unrealistic in their perception of *some* of their memory abilities. Perhaps there is something special about learning social information, such that when learning people's names, younger and older adults' metacognition is more accurate than when learning other types of information.

Overall, Experiments 1 and 2 and in Study 3, focused on participants' memory for information *about* other people. In Experiments 4 and 5, the focus shifted to examining how people remember information that they could use when communicating *with* other people. Using a paired associate learning paradigm with English-Swahili word pairs, two Experiments assessed how younger and older adults remembered foreign language vocabulary that varied in its importance. Participants were told to imagine going on a trip to Kenya, which certainly supported the use of Swahili-English pairs as opposed to another language, but Swahili words were primarily chosen because they are not likely to be familiar to most participants in America (compared to, for example, French or Spanish words) and, perhaps even more importantly, because they do not easily lend themselves to common encoding strategies (e.g., imagery). Because the words are difficult to learn, we predicted participants would use a different type of strategy to guide their learning: value. That is, participants would remember the words that were most important for them to learn on their trip. Overall, younger adults remembered more pairs than older adults did, which is in line with previous work on age-related associative deficits. Both age groups learned with task experience as the words were repeated on a second study-test trial, but pre-task ratings suggest that all words were considered relatively important, without much variance among the categories.

Experiment 5 sought to create a larger contrast in importance: some categories of words were selected from Experiment 4, to which were added words that were less important to learn for a trip (e.g., common objects such as “pen”). Though pre-task ratings were again not sensitive to value, younger and older adults’ paired associate learning accuracy did differ between these two types of words, such that higher-value words (e.g., “doctor”) were remembered more accurately than lower-value words (e.g., “desk”). The results suggest that participants were not aware that they should prioritize information until they actually attempted to study and/or recall the items, after which they realized that prioritization was necessary to remember the information that was actually more important to learn for their trip. Participants benefited from the opportunity to learn from their mistakes and adjust their learning strategies on a subsequent study-test trial.

Overall, Chapter 2 illustrates that under certain circumstances, younger and older people can prioritize important associative social information, and that they are generally aware than remembering some types of social information (e.g., people’s names) can be difficult. Participants often benefited from repeated study-test trials, and while value-directed strategies were not always present from the beginning of the task, many participants learned to prioritize with task experience: when they recognized that they were not able to remember everything, participants directed their resources toward information that was most important to know.

Younger and older adults’ memory for important health-related information

While Chapter 2 focused primarily on socio-emotional goal pursuit in learning, Chapter 3 focused on knowledge-based goal pursuit, specifically in learning health-related information. Health-related information can be important to remember, but easily confusable: many people, especially older adults, take multiple medications and/or supplements at the same time. Due to the commonality of complex medication regimens, participants may benefit by knowing which medications should or should not be taken concurrently (Experiments 1 and 2), and which side effects are associated with which medications (Experiments 3 and 4).

In Experiment 1, participants were presented with pairs of medications or a medication and a substance (e.g., grapefruit), as well as the severity of the interaction that would occur should those two items be consumed together. In some of the pairs, there was said to be no interaction between the two, in others, there was said to be an interaction that was mild in severity (e.g., headache), and in others, there was said to be a severe interaction (e.g., stroke) should the two items be consumed together. Participants were presented with these pairs during repeated study-test cycles and were tested using an associative recognition memory paradigm in which they were shown the pairs of medications and asked to recall what would happen should those two be taken together (i.e., severe, mild, or no interaction). Only older adults' recognition accuracy was affected by the severity of the health outcome in Experiment 1. There were no significant age-related differences in memory performance, which was somewhat surprising, given that older adults often struggle with age-related associative deficits in memory (e.g., see Chapter 2, Experiments 4 and 5).

Perhaps younger adults felt that the learning task in Experiment 1 was easy enough that they did not need to prioritize the severe items, thus leading to no effect of severity on memory performance. In Experiment 2, the task was modified such that it was relatively more difficult than in Experiment 1: Instead of studying unique, non-repeating pairs of medications, participants in Experiment 2 completed a task that involved interference in memory. Based on prior work investigating the "fan effect" in learning, Experiment 2 paired one medication with five others to create a task in which participants were required to learn both items in the pair and match them to the severity of the health outcome in order to know the correct response. Older adults are thought to be differentially (negatively) impacted by interfering information in memory, but again, surprisingly, younger and older adults' memory performance did not differ (perhaps at least partially due to the simplicity of the recognition test). The results were different from Experiment 1, however, in that both age groups' recognition accuracy was affected by severity, such that the outcomes associated with the most severe health consequences were recognized with the highest accuracy. Taken together, Experiments 1 and 2 suggest that younger and older people can remember associative information about medication interactions that vary in severity. Participants in both Experiments learned with task experience, and an age-related associative deficit was not established – though it certainly would be in Experiments 3 and 4.

We often share information about medical diagnoses and treatment plans with loved ones, friends, and/or spouses. When we share this information – such as what medications the doctor has prescribed to us, or when we should begin our new medication regimen – it is helpful for us to have an accurate perception of our own memory's fallibility, as well as others'. However, overconfidence in memory is fairly common, and it could have negative consequences in the health domain if we commit memory errors without realizing we have the propensity to do so. Experiments 3 and 4 were constructed to assess whether younger and older people were overconfident in their ability to remember associative health-related information, and, if so, whether a short but challenging task could affect that overconfidence.

In Experiment 3, younger and older participants read a short description the learning task and then made judgments about how well they and other people (a same-aged peer, a first-year medical student, and a member of the other age group) would remember a set of pairs of medications and their side effects. Critically, new pairs were presented on each list, and participants were told of this design before they made their metacognitive judgments. After these estimations, participants completed a series of study-cued recall test cycles before making judgments about themselves and others (the same people as in the pre-task judgments) after the final test. The task was designed to be difficult without appearing so on its face, to assess whether participant's likely overconfidence would change after they were faced with the fallibility of their memory. Participants were not just *told* that memory is fallible – they experienced it firsthand. While participants estimated pre-task that they and a same-aged peer would remember approximately 50% of the information presented (perhaps relying on a metacognitive anchor by picking the midpoint of the 0-100% scale), they performed significantly worse than they estimated, and their post-task estimations were adjusted downward. Interestingly, both groups continued to rate medical students as being able to remember a fairly high number of items, suggesting they did not view the task simply as impossible, but surely difficult for those who do not have much familiarity with the information and/or are not interested in learning it.

In Experiment 4, participants were able to learn with task experience: the pairs of medications and side effects were held constant across the task, rather than changing on each list. Participants still tended to estimate that they would remember about 50% of the items presented, providing more evidence for the use of a metacognitive anchor near the midpoint of the scale. For older adults in particular, judgments were higher pre-task than post-task, especially when making judgments about their own memory accuracy.

Younger adults outperformed older adults in memory accuracy, but both age groups were largely overconfident before learning in Experiments 3 and 4. Overall, Experiments 3 and 4 suggest that a short but difficult task can affect overconfidence in learning associative health-related information. The learning illustrated in Experiments 3 and 4 can provide two benefits: in a relatively short but difficult memory task, participants can learn the content they do not know (which may be important in a clinical and/or pharmaceutical setting), while also learning that because memory is fallible, they should not rely solely on their own capacity to remember a large amount of information, but rather use strategies such as taking notes to aid their recall.

Effect of importance on offloading and remembering

We often use external sources to help us remember information. We take notes during important lectures and review those notes while studying for exams, we use calendars and to-do lists to help organize our daily lives, and we bring a list to the grocery store to ensure we purchase the necessary ingredients for a new recipe. We may offload this information because we realize that our memory capacity is neither infinite nor perfectly accurate, and we need help remembering information that we will want to revisit later. The purpose of Chapter 4 was to investigate whether and how participants used a computer-based offloading system in a memory task in which they were asked to remember a set of words (though there were, by design, more words present than participants could hope to remember).

In Experiment 1, participants offloaded the maximum amount of words they were able to, and rarely recalled those words on future free recall tests. Participants trusted that the offloading mechanism would work, that is, that it would "remember" the information they saved to it. On a surprise final recognition test, participants recognized words they offloaded less accurately than words they recalled, but they did recognize offloaded words more accurately than they committed false alarms (by saying they had seen lures that were not presented during study). That is, the words offloaded during study in Experiment 1 were not completely forgotten.

Experiment 2 incorporated a value structure to determine how information importance affects offloading decisions, and how those decisions in turn may affect recall and recognition performance. When we offload information to a to-do list, we may write down the most important information (e.g., "attend an important meeting on Wednesday at 10:00am"), but not information we consider as less critical to remember – or, put another way, information we consider unlikely to be forgotten (e.g., "walk the dog this evening"). In Experiment 2, words were randomly paired with point values, and participants were told that their goal was to maximize their score, which would be calculated by summing the points associated with the words they offloaded and recalled on each list. Again, participants used the offloading mechanism to its fullest extent: they overwhelmingly chose to offload six words on each list, and those words were often the six words associated with the six highest point values.

Unlike in Experiment 1, however, offloaded words were not very accurately recognized: they were recognized at the same rate as words that were not presented during study were inaccurately chosen as having appeared (i.e., false alarms to lures that were not presented during study). In Experiment 2, the self-directed forgetting of offloaded, high-value words was substantial, perhaps because their offloading goal was obvious compared to participants in Experiment 1: if you trust the offloading mechanism, you should find and save the six highest value words and then devote the remaining time to studying the other words. In Experiment 1, the offloading goal was not so obvious, perhaps leading to deeper encoding of the offloaded words as offloading decisions were made, which led to stronger memory traces of those items, and thus more accurate recognition of those words later.

Incidental memory for items that were not delibrated about during the offloading decision was at least partially preserved. In contrast, when there was not much deliberation about whether to offload a given item (e.g., for the high value items in Experiment 2), that item was not later recognized. To further assess this proposed explanation, we can manipulate the amount of deliberation involved in the offloading process. While directly instructing participants to deliberate or not about their decisions might be the most straightforward way to test our assumption that more deliberation during offloading leads to more accurate incidental memory, perhaps more sophisticated manipulations are of interest. These potential avenues of interest are discussed in the next section.

Overall, the results of Experiments 1 and 2 in Chapter 4 suggest that people are willing to use offloading mechanisms to save information that is important to their goals, and that saved information is, under certain circumstances, not completely forgotten.

Future directions

Younger and older adults' memory for important social information

To build upon Experiments 1 and 2, future work can manipulate actual future use of social information. In the studies reported above, participants were asked to *imagine* that they were more likely to use a subset of information than they were to use other information in the future. If participants were studying some information they would *actually* use in the future and some information they would not use, the need probability manipulation may influence both younger and older adults' performance. For example, meeting a group of people (digitally or in real life) and having to tell another participant (or confederate) about the people they met would likely create an even stronger value manipulation than was used in Experiments 1 and 2.

In addition, future work could assess the role of impression formation on memory for important social partners. Impression favorability could be manipulated as a competing variable with value, such that people with a lower need probability make a better impression on participants. If this manipulation occurred, which variable would have a stronger effect on recall?

Study 3 can be modified into an experimental design: perhaps with a spotlight-inducing manipulation, participants would be more accurate in their memory for names that would actually be tested (rather than only surveyed). For example, some participants could be asked to retrieve specific examples of forgetting other peoples' names (as compared to forgetting locations, facts, or even more common activities such as where they placed their keys) before completing a memory and metacognition task. This type of retrieval would bring their memory failures to mind, and perhaps making examples of forgetting highly available could decrease the better-than-average bias for several types of memory.

In Experiments 4 and 5, older participants were not particularly accurate in learning Swahili-English word pairs. Future work could investigate how to improve this type of memory, as travelling throughout the lifespan may require learning some important words. For example, if older adults are explicitly told to use a certain memory strategy such as value-directed remembering when learning these PAL stimuli, will their performance improve compared to when they are not given such instructions? Further, technological advances in language-learning smartphone applications may make memorizing foreign language vocabulary easier (or perhaps not even necessary, if the content is available during one's travels). Incorporating study techniques from apps like Duolingo or Memrise may reflect a more accurate representation of how people actually learn this type of information. Participants could be allowed a sort of "cheat sheet" in which they are encouraged to write down the information that they would like to know for their trip, and performance in this condition could be compared to using an app to learn. In this line of work, another study could allow participants to choose the categories they find most important (e.g., the food-related category and the health-related category) and study those, in addition to some other words considered less important. The participant pool itself could also be adjusted: seeking out older adults who will be going on an international trip (perhaps through an older-adult-focused travel organization such as Road Scholar or Elder Treks) and asking them to rate and learn the information in Experiment 5 could capture an audience that is likely to be interested in and/or experienced in learning new information about foreign countries. This technique could shed light on age-related differences in which types of words are considered most important, which the pre-task ratings in Experiments 4 and 5 did not clearly explain.

Younger and older adults' memory for important health-related information

Experiments 1-4 used highly-controlled, randomly paired medication stimuli from a normed database. While these stimuli are helpful for internal validity, the external validity of the studies could be increased by assessing participants' own medication regimens and presenting them with information that is more directly relevant to their health. Future work may also examine how this type of associative health-related information is remembered in a more applied context, as the information in this study was presented on a computer screen (rather than as actual medication bottles, which may lead to more accurate recall).

Based on findings from Experiments 3 and 4, future work may add local (item-by-item) judgments of learning for a deeper investigation of the underconfidence with practice (UWP) effect and whether this type of metacognition changes with age. Additional work may investigate the role of older adults' stereotype threat and/or anxiety on performance (e.g., Geraci & Miller, 2013), as stereotype threat can certainly have a negative impact on memory accuracy, but perhaps can also have a beneficial impact on metacognition (making memory estimates about oneself lower and, as a result, more in line with actual performance).

Experiments 3 and 4 revealed interesting metacognitive judgments about first-year medical students. Do participants believe that expertise with medications improves memory for them? If so, are there memory differences among new and experienced medical students, physicians, and pharmacists? Alternatively, are participants' metacognitive ratings driven by perceived interest in the material? If that is the case, are medical professionals truly more interested than others in learning new medication information, and does that affect recall? Future research can also assess how younger and older patients follow their doctors' advice and the effectiveness of their strategies.

If future work seeks to improve peoples' memory for health-related information, studies may assess how patients take notes while learning about new medications or diagnoses – not just what they write down, but also how manipulations of speed of information presentation and/or material organization may affect what is offloaded and what is remembered. Further, context may be important in learning information about new medications: does telling people the purpose of a medication (e.g., to decrease plaque buildup in arteries) help them remember it better than other contextual information (e.g., its size, color, and shape)? Does one's optimal time of day affect when they choose to visit the doctor or pharmacist, and how much they remember during those visits? In addition to extensions relevant to patients, the Experiments in Chapter 4 have practical implications for healthcare practitioners: for example, how students in medicine, pharmacy, and nursing learn about new medications, as well as what they know about how their patients learn.

Effect of importance on offloading and remembering

When we offload important information, we trust our devices to remember what tasks we need to accomplish, what groceries we need to purchase, or which dates are important to celebrate. Many of us have also had the misfortune of learning that the information we thought we had saved has been lost — possibly due to a computer error in recording our to-do list, or perhaps because we left our grocery list at home. These instances may require us to try to recall important information that we thought we could save and have access to later, but in fact is no longer available to us. A sense of uncertainty can arise when there is not complete trust in the device doing the saving. If we are aware that the device onto which we offload information is fallible, there is more risk involved in relying on it to save important information than if the device was completely trustworthy.

Future work could examine two circumstances in which there is a risk of forgetting: of course, the participant himself could be at risk to forget the items he studies, but there could also be a manipulated level of risk that the computer itself will "forget" (i.e., not accurately record) the words the participant wishes to save. Risk of the computer forgetting will likely cause uncertainty in the learner, which is expected to affect encoding strategies and retrieval performance. The less trust the participants have in the offloading system, the more they are expected to rely on their own memory for the highest-value items. These items may be offloaded, but may also possibly be recalled at test, as participants may want to make sure that they earn points associated with the offloaded words, in case the computer commits an error. The uncertainty could also affect overall recall performance, as participants who can fairly reliably predict what the computer will do are expected to have more cognitive resources to devote to encoding and therefore recall more words at test (without considering the offloaded words). Thus, if future work incorporates risk and uncertainty, participants in higher-uncertainty conditions (i.e., when the computer will save the words 25%, 50%, or 75% of the time) could be expected to face more cognitive load at encoding as they seek to remember valuable items just in case the computer fails, while participants in the lower-uncertainty conditions (i.e., when the computer will save the words 100% or 0% of the time) would not face the cognitive load of anticipating what the computer will do and should study and learn accordingly.

The potential metacognitive extensions of this paradigm are also interesting. Are participants aware of how much they rely on the offloading system? If they were to lose access to their saved words, would they accurately assess how well they learned those words? Or would they assume that they would remember saved words better than other types of words just because they made decisions about those words? Metacognitive judgments about the relationship between (and comparative accuracy of) oneself and the external offloading mechanism may reflect an accurate representation of how we work with technology (after all, many of us use computers as remembering devices quite frequently; Hamilton & Benjamin, 2019), or perhaps a misunderstanding or underestimation of how much the external system really helps us remember.

Additional future work based on Chapter 4 could manipulate the memorability of the studied and offloaded words by varying the frequency and/or concreteness of those words (e.g., Tullis & Benjamin, 2012). This manipulation could uncover how word-based characteristics (compared to, or in contrast with, value) may affect offloading decisions and/or memory accuracy. If more deliberation for each item during offloading leads to better incidental memory, we expect that words that are associated with easy decisions to offload should be less accurately recognized. If participants are sensitive to how word-based characteristics such as frequency and concreteness may affect their memory, they should offload the words on those dimensions that would lead to least accurate remembering. Regardless of how exactly it is instantiated, we expect that increasing the deliberation involved in judgments about offloading will benefit later incidental memory.

Conclusions

The primary goals of this Dissertation were to assess how healthy aging and information importance may affect memory and motivation to learn, with potential applications to social (Chapter 2), health (Chapter 3), and educational (Chapter 4) domains. Substantial prior work supports a general shift in priorities with aging, from younger adults pursuing knowledge-based goals to older adults pursuing socio-emotional goals. While this framework is certainly helpful and is supported by evidence in many cases, it is also of interest to consider situations in which these goals may overlap (as in Experiments 4 and 5 in Chapter 2), or when learners may pursue new knowledge to achieve an experimenter-designated goal (e.g., learning health-related information in Chapter 3, or achieving a high score in Chapter 4).

In Chapter 2, younger and older adults remembered important associative information that was in line with socioemotional goal pursuit under some circumstances. Experiments 1 and 2 and Study 3 assessed how younger and older people remembered information *about* other people, as well as their awareness of their ability to do so. Experiments 4 and 5 assessed how younger and older people remembered information they could use with communicating *with* other people, and while younger adults did outperform older adults overall, both groups did remember important information given a structure that lent itself to value-directed remembering. In Chapter 3, Experiments 1, 2, 3, and 4 investigated how knowledge-based learning goals about medical information may affect memory and metacognition in younger adults. Experiments 1 and 2 suggest that older adults (and, when they are challenged, younger adults) prioritize important health-related information across several study-test trials, and Experiments 3 and 4 illustrate how a difficult task can affect overconfidence in one's own (and others') abilities to remember health-related information. Finally, Experiments 1 and 2 in Chapter 4 illustrate how the decision to save certain information to an external source can affect memory as measured by both recall and recognition, which has implications for how learners study information of varying importance and how they use technology while learning.

Overall, the results presented in this Dissertation suggest that older adults are often able to overcome, or are not always harmed by, established deficits in binding multiple unrelated items together in memory. Participants across the adult lifespan can benefit from being given multiple study-test cycles and indications of what information is important to learn. Though age-related associative deficits are found in certain circumstances discussed in the current Dissertation (e.g., in Chapter 2, Experiments 2, 4 and 5, and in Chapter 3, Experiments 3 and 4), older adults perform as well as their younger counterparts in other associative domains (e.g., when the information is highly important; see Chapter 2, Experiment 1, and Chapter 3, Experiments 1 and 2). Chapter 4 suggests that learners can use saving mechanisms effectively, both in the amount of information they save and in the importance of the information they save, but that saving information can negatively impact incidental (recognition) memory if that saving does not require much or any deliberation.

Goal pursuit, learning, and value

Substantial prior research supports the shift in goals from knowledge-based to socio-emotional across the adult lifespan. The theoretical contributions of the current work include the notion that value – in an objective and/or subjective sense – can supersede this general pattern. That is, if learners consider a set of information important to know to achieve their goals, they are often able to direct their attention and cognitive resources accordingly, regardless of whether it is socio-emotional in nature. In some sense, the predictions of age-related shifts from knowledge-based to socio-emotional goal pursuit are overly limiting, given the findings of the current work and other work outside the realm of this dissertation (e.g., see Hargis, Siegel, & Castel, 2019, for a further discussion). The assumption that knowledge-based goals are not important in older adulthood certainly reflects the relatively small percentage of older people enrolled in university classes or engaged in formal educational programs, but it largely overlooks the everyday pursuit of knowledge-based goals in aging.

How, then, should we understand shifts in learning new information that are associated with cognitive aging? Of course, these shifts are well-established, and the idea that learning goals change with age is not argued here. Rather, to fully understand changes in motivation across the adult lifespan, we should consider not just that older adults seek to build relationships and regulate emotions above all else, but that a more general notion of value or importance could be in fact the primary mechanism driving goal pursuit in older adulthood.

Benjamin (2010) provides convincing evidence via computational modelling that rather than specific deficits (e.g., source and context memory, or associative information), older adults face a global degradation of memory accuracy. That is, aging does not affect particular modules of memory, but the entire memory system. Established deficits in source memory and associative memory, for example, may not be caused by particular difficulties with those types of learning, but because that information is represented with lower fidelity – what Benjamin (2010) refers to as "sparse" representation in the memory system (p. 1063).

On its face, it may seem like a value-based mechanism such as the one discussed here does not fit well with a theory of global deficits. If older adults are overall less accurate than younger at remembering associative information because of global loss of fidelity and sparsity of representation, how would the results of age-equivalence in learning some types of associative information in, for example, Experiments 1 and 2 of Chapter 2 be compatible with such a theory?

The same could be said of age equivalences in another associative memory task presented in Chapter 3, Experiments 1 and 2. However, I suggest that a broader value-based mechanism is not only compatible with a theory of global deficits, but can be supported by such a theory. If age-related deficits in memory are due to certain types of information (e.g., associations and sources) being represented more sparsely than other information, it serves to reason that other types of information, when represented more densely, would be remembered more accurately. That is, higher value leads to denser representations, a claim which is agnostic to the specific format of the to-be-learned information (e.g., whether it is associative or not). While Benjamin (2010) explains age-related losses in memory, understanding the effect of value or importance on learning can help shed light on older adults' preserved abilities that were illustrated in the Experiments mentioned above and elsewhere.

The difference between subjective and objective value is an important one to discuss, as what is important to one person may not be important to another. In several of the studies in this Dissertation, value was manipulated by the experimenter, but it is also worth considering how subjective importance that is driven by the participants' interests and/or knowledge affects motivation. The older adult who enjoys birdwatching devotes time and energy to learning migratory patterns and eating habits – not because the goal will necessarily help him build relationships with loved ones (though, of course, he could join a birdwatching group), but because learning new information is his priority. The information has high subjective value (see McGillivray & Castel, 2017; McGillivray et al., 2015; and Middlebrooks et al., 2016). New information about his hobby can also be viewed as fitting within that individual's schemas for learning. In contrast, when an experimenter randomly assigns some medication pairs to be associated with a severe health outcome, for example, the value of that information is being manipulated more objectively (in fact, randomly). Objective value may be simplest to illustrate and manipulate in a lab-based task, but we also often encounter information that others view as important in the real world: our professor tells us that we should study certain information for an upcoming exam, our pharmacist tells us that we must take exactly 10mg of the currently-prescribed medication, and our partner tells us that we really need to pick up chocolate milk from the supermarket.

When these two types of value – what we think is important and what others think is important – align, memory should be represented more densely than when those two are not aligned or, worse, when they are in conflict. The *densest* representation, to use Benjamin's (2010) terms, should be for information in which subjective and objective value overlap – for example, if we see it as important to get our dosage exactly correct and the pharmacist mentions that they do too, that information is represented densely. A sparser representation would occur for information that is either one type of value or the other – for example, our partner thinks chocolate milk is important to buy at the store, and we think bread is important to buy. These two items still have value, but perhaps are less likely to be learned than if the idea of what is most important was aligned.

Finally, the sparsest representation of the three types would be for information about which the two types of value conflict – for example, I believe that learning the names of famous experimenters and the years in which they published major studies is important for my Psychology exam, but another student in the course tells me that those items will not be tested. (Alternatively, perhaps value conflict makes certain information distinct, and thus more memorable – certainly an empirical question.) In this case, I think something is important to know while another person thinks it's unimportant. I may adjust my perception of subjective value and/or my learning strategies based on this conflict. The extent to which I change my opinion of value depends, of course, on the person with whom my perception of importance in conflict: if I think something is important but a fellow student does not, I'm probably less likely to change my interpretation of value than if the professor tells me that what I thought was important to know actually is not. That is, the level of authority from which the "objective" value is projected affects my subjective value judgments.

I have not included one type of information in these examples: information that has neither objective nor subjective value. It would be interesting to compare whether conflict between subjective and objective value is learned more or less accurately than information that is not valuable at all, but according to the current framework, information with low value would have very sparse representation in memory (in a sense, if it is not important to anyone, why should the learner bother learning it?) and would thus be learned least accurately.

The subjective/objective value difference explored above is not the only way to conceptualize differences in value, however. Perhaps it is more generalizable to think of a two-tiered value system: the first threshold is the motivation to actually begin a task (e.g., to show up to a memory study). For younger adults who participated in the Experiments in this Dissertation, the value earned was credit for their college courses (though many may also have been curious about the tasks at hand). For older adult participants, their motivation to attend was often to learn more about their memory, to "exercise" their mind, and, for some, to earn money as compensation for participating. If we consider this value "alpha" – the initial motivating force that leads people to begin a task – we can also consider "beta" value, or the in-task motivation to learn certain things (often at the expense of others), as well as how performance may improve with task experience.

Consider a student in a college course. The alpha value for this student to go to lecture may be increased by thoughts of how much money it costs to attend college, how excited he is to learn the material, and/or how important the course is to his major or career goals, among others. These factors get him into the room. Then, once he is in class, the beta motivation to learn comes into play: how does he take notes to determine what is important to him to know? Does he simply transcribe the lecturer's words, or does he exert some kind of learning strategy to pay attention to the most difficult or important content? The difference between alpha and beta here is not only the difference between extrinsic and intrinsic motivation, though those terms are certainly helpful, and the constructs do contribute to each value factor. Instead, this notion includes more of a first-order and second-order conceptualization of value, importance, and motivation which can be extended to learning and non-learning domains and can be adapted for individuals throughout the adult lifespan.

In conclusion, as is argued throughout this dissertation, the instances in which older adults seek to learn new information are not merely superficial exceptions to the overall pursuit of socioemotional goals, but are worth incorporating into theory. A focus on value as the driving force behind goal pursuit is both more general and more personalizable than other frameworks: rather than being pigeonholed into socio-emotional goal pursuit, we can consider a broad value mechanism that drives older adults' decisions while also allowing for the fact that an individual's perceptions about what is important can be highly personal. (Helpfully, those perceptions can also be affected by the experimenter's instructions about what is important.) The current work sheds further light on the potentially contrasting theories of socio-emotional goal pursuit and a broader, more general value-based goal mechanism in older adulthood.

Goal pursuit changes across the lifespan, as does the motivation to learn. The current research suggests that even in light of some deficits in memory that are associated with healthy cognitive aging, older adults can remember important associative information given the opportunity to learn with task experience. When we are presented with more information than we can hope to remember, we are often able to prioritize that which is most important to achieving our goal – whether that goal is to remember information about a social partner, information about a new medication regimen, or information that helps us achieve a high score on a test. Continued research can further investigate how motivation and value affect learning across the adult lifespan, but the current work suggests that, especially when given the opportunity to learn from their mistakes, people young and old can learn information that will help them achieve their goals.

Appendix

Chapter 2, Study 3

Items Used to Assess the Better-Than-Average Effect, Rated on a Scale from 1-9

How would you say you compare to others your age in terms of leadership ability?

How would you say you compare to others your age in terms of ability to get along with others?

How would you say you compare to others your age in terms of honesty?

How would you say you compare to others your age in terms of capacity for hard work?

How would you say your memory compares with that of others your age?

How would you say your memory for historical figures (e.g., Napoleon) compares with that of others your age?

How would you say your memory for scientific terms (e.g., photosynthesis) compares with that of others your age?

How would you say your memory for locations compares with that of others your age?

How would you say your memory for people's names compares with that of others your age?

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