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MOTIVATED MEMORY, LEARNING, AND DECISION-MAKING IN OLDER AGE: SHIFTS IN PRIORITIES AND GOALS

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Our goals across the lifespan often include gaining new knowledge, building relationships, and staying healthy. A younger adult's goals may center on his or her acquisition of knowledge to succeed in a career, whereas older adults' goals shift toward emotion regulation, and many may seek to build and maintain relationships with loved ones. However, motivation appears to be more complex than a single theory, such as lifespan theory of control (e.g., Heckhausen & Schulz, 1995) or socioemotional selectivity theory (e.g., Carstensen, Isaacowitz, & Charles, 1999), may suggest because older adults also pursue learning for the sake of acquiring knowledge or to satisfy their curiosity and spend time on hobbies such as bird-watching and traveling, and younger adults may spend time in romantic relationships seeking lifelong partners. Thus, younger and older adults are likely to have many

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goals in common, but the pursuit of these goals may be different, based at least partially on the resources available to pursue such goals.

For instance, in the context of memory, younger and older adults likely have different performance abilities and functional goals. When we are faced with a large amount of information in our environment—when learning about a new medication in a doctor's office, for instance, or when learning a new language—our goals often influence what we attend to and whether we remember it later. A middle-aged or older adult's goal may be to learn Spanish phrases to help them communicate on an upcoming trip to South America with family or friends, while a younger adult in a Spanish language class could be motivated to learn Spanish verb conjugations to attain a high score on the next exam. Older adults may also learn new languages to keep their brain sharp and as a way to challenge themselves. In another context, an older adult may remember the most important information shared by his or her doctor (perhaps that which would lead to dangerous health outcomes), while a younger adult may have more processing resources at hand to remember large amounts of medical information.

In this chapter, we examine how and why motivation changes across the lifespan in the domains of learning, memory, and decision-making. We discuss how goals might change in light of perceived time horizons, particularly shifting toward social and emotional goals with age. However, we also explore the notion that curiosity and interest can be strong motivations to learn new information, in both formal and informal learning environments. We highlight in particular how younger and older people remember information that is made important to them either by the experimenter through the assignment of higher point values to certain items (e.g., Castel, 2008) or as a more practical feature of the stimuli (e.g., dangerous medical outcomes; Hargis & Castel, 2018), including a discussion of the critical role of attentional control during encoding and an exploration of the potential underlying neurocognitive mechanisms. We then explore decision-making and aging in a variety of contexts that reflect how goals and priorities may (or may not) change across the lifespan and how intrinsic versus extrinsic motivational factors may differentially affect cognitive processes during the aging process.

SHIFTING GOALS ACROSS THE LIFESPAN

Socioemotional selectivity theory (SST) focuses on the shift from knowledge acquisition goals in younger adulthood (typically college students under age 30) to emotion regulation goals in older adulthood (typically people over age 65). We perceive our future lifespan as more limited as we age, but also when younger adults experience endings such as graduation

(Ersner-Hershfield, Mikels, Sullivan, & Carstensen, 2008) or are suffering from a serious illness (Carstensen & Fredrickson, 1998). This recognition of the limited nature of the future causes individuals to focus more on emotion-related goals, such as maintaining relationships, and to expend more of their resources (cognitive and social) in pursuit of them. Emotion regulation, a processing component that is largely spared from age-related cognitive decline (Charles & Carstensen, 2007), is thought to be promoted by this shift toward emotional goals. Motivation is intricately tied to memory, especially in aging; if more of older adults' goals are related to emotion, their memory for emotional items may be preserved, in contrast to other declines in memory. For example, older adults more accurately remembered a product's slogan if it included an emotional component (e.g., "Capture those special moments" for a camera advertisement), compared with a nonemotional component (e.g., "Capture the unexplored world"; Fung & Carstensen, 2003). This difference was eliminated, however, if participants were first asked to imagine that a life-extending medication would allow them to live 20 years longer than they expected to live, indicating that perceived time horizons are in fact a major component in this type of processing. SST suggests that self-regulation influences memory and attention, such that cognitive resources in those domains are directed toward emotional information as goals shift in older adulthood.

Carstensen and Mikels (2005) argued that a key factor in processing information as we age is the *positivity effect*, which is closely linked to, and possibly caused by, the shift in goals accounted for by SST (see also Kan, Garrison, Drummey, Emmert, & Rogers, 2018). The positivity effect, or the tendency to focus on positive rather than negative information, is often present in older adults' recall of emotional information (Mather & Carstensen, 2005). Younger adults do not usually show this favoring of positive information; in fact, evidence suggests that they actually display a negativity bias in recall. In line with predictions made by SST, emotional information seems to be processed differently by younger and older adults; because older adults' time horizons are perceived as more limited and the goal of emotional well-being becomes more salient, information may be processed in such a way that positive information is maximized and negative information is minimized (Mather & Knight, 2005). Further, when younger adults are primed to think about their time horizons as limited, they recall positive information at a higher rate than if they think about expansive time horizons (Barber, Opitz, Martins, Sakaki, & Mather, 2016), suggesting a strong connection between perception of future time and the positivity effect. However, when older adults are unable to devote sufficient cognitive resources toward pursuing a goal (e.g., when completing an unrelated task simultaneously during study), the positivity effect is not present in recall. In fact, those who studied under dual-task conditions were actually more likely to recall negative information than positive (Mather & Knight, 2005).

Although the empirical evidence to support a shift in goals from knowledge acquisition to emotion regulation is strong (Carstensen, 1992; Carstensen, Isaacowitz, & Charles, 1999; Fung & Carstensen, 2004; for a more in-depth review of the brain-based mechanisms underlying SST, see Chapter 6, this volume), it is also worth examining the situations in which older adults continue to seek knowledge. Old age does not necessarily lead to a halt in pursuing goals that promote the acquisition of new information in daily lives. For example, older adults, when retired, may travel frequently. If an older adult is planning a trip to a new city to see family, this could be thought of as an emotion-based goal on its surface because the emotional connections with family members will likely be strengthened. However, the additional information that one may learn in preparing for this journey—from the best transportation options to the airport to information about the art history museum they wish to tour—can be considered as acquiring new knowledge that would be in the service of a broader, emotional goal. That is, older adults' lives are often not confined to only the pursuit of emotion regulation. Instead, goals that are less emotional are often pursued, such as learning trivia, becoming an expert birdwatcher, or completing crossword puzzles. Motivation, therefore, is a multifaceted domain in aging, and understanding what motivates older adults in their daily lives can be more complex than a single theory may suggest. We further note that motivation is a significant component in the construction of memory tasks (e.g., Jenkins, 1979), and this can be especially important when considering age-related differences and similarities in how younger and older adults might approach certain memory tasks.

Further, the motivation to engage in a behavior depends on the level of self-determination associated with completing said action. Motivations that are completely self-determined are deemed *intrinsic*, whereas motivations that stem from some external factor(s) are considered *extrinsic*. Actions that are intrinsically motivated arise due to an internal desire and are done so for one's own pleasure, often in the absence of any material reward (e.g., watching a favorite movie). Extrinsically motivated behaviors, on the other hand, arise when there is potential to earn some external reward (e.g., working overtime to earn extra money) or to avoid consequences associated with not completing said behavior (e.g., exercising to mitigate negative health outcomes). Many actions we take are associated with both intrinsic and extrinsic motivational factors that may differentially contribute to younger and older adults' behaviors. Take, for example, younger and older adults' participation in psychological experiments. In the authors' experience, younger adults tend to be extrinsically motivated to come into the lab to participate in experiments, generally to earn course credit (the earning of which is not usually dependent on task performance) or a small monetary reward. In contrast, older adults tend to be intrinsically motivated to participate for the most part: Although they also earn monetary rewards, the small sums that they do earn are often not the main factor in their motivation. Anecdotally, older adults often report being more interested in the "experience" of participating, "exercising" their memory, and being able to contribute to the advancement of science. It is important to note, however, that this is not the case in all circumstances; younger adults can be intrinsically motivated and older adults extrinsically motivated to participate, dependent on various factors, including personal interests, personality characteristics, and socioeconomic factors.

In the context of a classroom learning environment, intrinsically motivated students are more likely to engage in learning to challenge themselves, satisfy their curiosity, and become experts in the given domain (Pintrich, Smith, Garcia, & McKeachie, 1991). Extrinsically motivated students are interested in learning as a means to an end—that is, to earn some external reward (e.g., for external approval, for an increased grade point average). Prior research has examined the relationship between these two types of motivation and academic performance among younger undergraduates. Vansteenkiste and colleagues (2004) found that students assigned to an intrinsic motivation condition were more persistent and ultimately received higher grades than students in an extrinsic motivation condition. Bye, Pushkar, and Conway (2007) extended this research to aging by including in their sample "traditional" undergraduate students (those aged 21 years or younger), as well as "nontraditional" undergraduate students (those aged 28 years or older). Participants ranging in age from 18 to 60 years completed measurements of intrinsic and extrinsic motivation to learn, interest in particular topics, and emotional well-being. Nontraditional (older) students reported more intrinsic motivation to learn (e.g., learning to challenge themselves, satisfy their curiosity, or master a certain topic) than traditional (younger) students, and intrinsic motivation was related to positive affect in both age groups. An earlier study by Donohue and Wong (1997) using a sample ranging in age from 19 to 57 years old also suggested that nontraditional students demonstrate higher achievement motivation than traditional students. Further, Wolfgang and Dowling (1981) suggested that older students (i.e., older than 18–22 years) are strongly motivated by cognitive interest in the subjects they study and weakly motivated by social relationships (e.g., "to make new friends") or external expectations (e.g., "to carry out the recommendation of some authority," p. 642), providing further evidence in support of the possibility that, in some cases, older learners seek knowledge for the sake of attaining it (e.g., McGillivray, Murayama, & Castel, 2015). Prior work has proposed the linkage of emotion, motivation, and cognition among young students (e.g., Meyer & Turner, 2006), and the effects of these components are also important to understand in older learners.

In a complementary line of research, Kim and Merriam (2004) recruited participants from a Learning in Retirement institute to determine the factors underlying their decisions to seek knowledge. According to this survey, interest in learning information was the strongest motivator in attending this institute, followed in strength by social contact, which is in line with previous work regarding the increasing importance of socially and emotionally relevant goals with age (e.g., Carstensen & Mikels, 2005). Somewhat surprisingly, among the lowest endorsed were items that explicitly included emotional-social goals, such as "to keep up with my children/others in my family," while items tapping into information-seeking goals such as "to acquire general knowledge" and "to seek knowledge for its own sake" were among the highest endorsed. Therefore, although pursuing emotional and social goals is undoubtedly important to older adults, their own interest in acquiring knowledge seems to also be a strong motivator, at least in the domain of learning in structured educational courses. In fact, 30% of American older adults participated in some sort of educational program in 1999 (Kim & Merriam, 2004), including those within universities and senior centers, and this percentage is likely to have grown since then with the advent of online educational resources and more senior-friendly university-based programs.

Some of the goals we set, however, are not possible for us to attain. Wrosch, Scheier, Miller, Schulz, and Carver (2003) examined the self-reported ability of younger and older adults to disengage from goals that were proven unattainable and instead engage with other, more attainable goals. For example, if one loses his or her job, the goal of affording a luxurious vacation this year may be put on hold or disengaged from entirely, but other goals such as finding a new source of income or saving more money may become more relevant. Being able to disengage from an impossible goal is a valuable skill, as is the ability to reengage with the next goal that is attainable. Wrosch et al. found that older adults, compared with younger adults, reported more ease in disengaging from unattainable goals and shifting instead to more realistic goals. This can be considered adaptive because older adults recognized that continuing to pursue an unattainable goal would waste resources. The interplay between interest in a goal and its pursuit is worth considering: Perhaps older adults are less able to disengage from emotion regulation or other valuable goals than those in which they do not have a reported interest, which would demonstrate that interest in a set of actions is not always beneficial and can sometimes be detrimental to effective pursuit of said actions.

One's goals can also affect his or her allocation of attention to certain information. Older adults tend to exhibit general impairments in selective and divided attention, as well as switching attention between multiple sources of information, thought to be due to a slowing of information processing (Salthouse, 1995) and a decline in processing resources that occur with advancing age (Craik & Byrd, 1982; for reviews of the effects of aging on attention, see McDowd & Shaw, 1999, as well as Kennedy & Mather, Chapter 2, this volume).

MOTIVATION TO ATTEND TO AND REMEMBER INFORMATION

Although older adults show general deficits in attentional resources, there is evidence that they can effectively allocate attention toward information they deem important. As previously discussed, SST describes older adults' shift to the pursuance of emotion regulation goals from knowledge acquisition goals earlier in life (Carstensen et al., 1999). This overarching goal of emotion regulation is then likely to influence older adults' attention. In one study, younger and older adults were shown two faces on a computer screen, one of which had a neutral expression and the other an emotional expression (positive or negative in various trials; Mather & Carstensen, 2003). After being shown the pair of faces, a dot appeared on one side, and participants were asked to indicate on which side (left or right) the dot was located as quickly as possible. Younger adults' response time did not differ across valence conditions, whereas older adults responded significantly faster for positive faces relative to neutral faces and significantly slower for negative faces relative to neutral faces, which was interpreted as an attentional bias toward the positive information. Similarly, when presented with various models of cars, older adults were more likely to pay attention to the positive features and less likely to pay attention to the negative features, compared with younger adults, indicating that this attentional positivity bias may also be present in more naturalistic settings (Mather, Knight, & McCaffrey, 2005).

When we are faced with more information in our environment than we can hope to remember, we might engage in a strategy to remember that which is most important to us or that which will be most likely to help us achieve our goal(s). Outside of the lab, this may occur when we make decisions about which items we need to bring on a trip: Our toothbrush seems important, but may be less so compared to our passport (McGillivray & Castel, 2017). *Value-directed remembering* (VDR) involves the allocation of more cognitive resources toward remembering important information (e.g., to bring my passport) and less of those resources toward remembering less important information (e.g., to bring my toothbrush; Castel, 2008).

Inside the lab, Castel and colleagues (Castel, Balota, & McCabe, 2009; Castel, Benjamin, Craik, & Watkins, 2002; Castel, Farb, & Craik, 2007) have developed a paradigm that engages such strategies, most commonly using words paired with point values. In the original VDR task (adapted from Watkins & Bloom, 1999), participants are presented with a list of words (often 10–12 words) paired with point values. If participants were to see 12 words, as in Castel et al. (2002), those point values would be from 1 to 12. Participants are told that their goal is to maximize their score, which would be calculated by summing the point values associated with the words they later recall. Study-test phases are repeated for multiple trials, with the hypothesis that strategy use or selectivity (or both) may change with task experience. Feedback is often given in the form of the amount of points associated with the recalled words. Older adults remember less information than younger adults overall, but they tend to recall the items with the highest values equally as well as younger adults when given task experience. Both age groups also tend to be more selective across the task, perhaps as they form appropriate strategies to remember the highest value items. This finding has also been extended to the visuospatial memory domain, suggesting that older adults' ability to selectively attend to and remember high-value information may generalize to areas other than verbal memory (Siegel & Castel, 2018).

If one were to consider only age-related cognitive deficits, particularly in working memory and processing speed (e.g., Salthouse, 1995), the finding that older adults remember less information overall would not be novel. However, when given this goal-oriented framework, older adults can be just as selective (and sometimes more so) than younger adults in remembering the highest value information (Castel, 2008; Castel et al., 2002). Even when the items presented are emotionally salient (e.g., the words *tragedy* or *joyful*), older adults retain cognitive control over their memory and are able to remember what is valuable (Eich & Castel, 2016).

Further evidence for older adults' ability to effectively allocate attention toward information that is important for one's goals stems from research investigating attentional control in a VDR task. Castel and colleagues (2009) investigated whether younger adults, healthy older adults, and older adults with a diagnosis of Alzheimer's disease (AD) could selectively allocate attention toward (and thus later remember) high-value information. AD is typically associated with severe memory impairments, but there is also evidence that these impairments are at least in part due to a reduction in attentional control (Balota & Faust, 2001). Not only did participants with AD recall less information overall, they were also significantly less selective toward high-value information than the healthy older adult controls. This decrease in selectivity in individuals with AD was attributed to impairments in the ability to strategically allocate attention at the initial point of encoding. Importantly, participants with AD were still somewhat selective, remembering a greater proportion of high- than low-value information; however, they were significantly less selective than healthy older adults indicating an issue with effectively allocating attention to execute a value-based strategy but not with recognizing the need for one. Additionally, younger individuals with impairments in attention were unable to perform efficiently on this VDR task (Castel, Lee, Humphreys, & Moore, 2011). As such, healthy older adults' ability to demonstrate optimal selectivity in this context suggests that they are able to effectively allocate attentional resources to information that they are motivated to remember.

Although examining the recall of words paired with point values has been extremely useful in examining value-directed strategies, other VDR work has used perhaps more ecologically valid stimuli. Remembering information about medications, for example, can be important but difficult, especially for older adults (for an example using medication stimuli, see Hargis & Castel, 2018). Older adults tend to struggle in remembering specific events or details (Zacks & Hasher, 2006) and associated items (Naveh-Benjamin, 2000), both of which could harm memory accuracy after leaving a doctor's office with information about a new diagnosis or medication. Friedman, McGillivray, Murayama, and Castel (2015) suggested that "subjective" selectivity—that is, the act of attending to information that is important based on the individual's goals or the setting of the task—could affect memory differently from "objective" selectivity imposed by the experimenter (e.g., by random assignment of point values to items). Relatedly, McGillivray and Castel (2017) allowed participants to assign point values to the items they were to take on a trip, such as a passport and a toothbrush, and found that items that were assigned high point values were in fact recalled more accurately than those assigned low point values.

In addition, recent work by Hargis and Castel (2017) examined how younger and older adults remember valuable social information. Participants studied a series of face–name–occupation items of differing social value to the participant, based on their likelihood of interacting with that person again (see Figure 5.1 for example stimuli) before being tested on that information with four cycles of study and recall, and were ultimately given a final cued recall test. When both age groups were given 3 seconds to study each item, there were no significant differences between younger and older adults' recall accuracy of the most valuable information, and both groups recalled this information relatively accurately (see Figure 5.2). Age differences in accuracy were present in recall of the lowest value information: Younger adults largely outperformed older adults when asked to recall the information about people whom they would not meet again. The likelihood of remembering information about people we meet may in part be due to our motivation to remember those who we consider important; older adults are not subject to established age-related deficits in associative memory when recalling this important information (Naveh-Benjamin, 2000; see also Fung, Lu, &

Figure 5.1. Example stimuli from Hargis and Castel (2017) using face stimuli from Minear and Park (2004). There were 20 items that varied with respect to the likelihood of the participant interacting with the given person again (e.g., one's new doctor was considered personally important due to the likelihood of future interaction). Younger and older adults studied each item for 3 seconds before four free-recall tests for name and occupation information and a final and cued-recall test. From "A Lifespan Database of Adult Facial Stimuli," by M. Minear and D. C. Park, 2004, *Behavior Research Methods, Instruments, & Computers*, *36*, pp. 630–633. Copyright 2004 by Springer Nature. Adapted with permission.

Isaacowitz, 2018), but deficits do emerge for low-value information, similarly to other VDR tasks (e.g., Castel et al., 2002).

However, memory for a short-term task goal (e.g., recalling this information on the next free recall test) may differ from memory for a task to be done in the future (e.g., mailing in postcards to the experimenter on a specified date; Einstein & McDaniel, 1990). When tested inside the lab, older adults' prospective memory (PM), or memory for things to be done in the future, is often less accurate than younger adults'. When given outside-the-laboratory tasks such as mailing in a postcard, older adults often perform more accurately than younger adults, creating what is known as the "age PM paradox" (Phillips, Henry, & Martin, 2008). This paradox may be better understood when considering how motivation changes with age. More recent work using daily diaries has shown that older adults' PM is more accurate than younger adults' in social and health situations (e.g., "pick up grandchild after kindergarten" or "do one hour of walking"; Schnitzspahn et al., 2016, p. 448), which may reflect older adults' increased motivation to pursue social and health-related goals. An older adult's motivation to perform well on a PM task outside the lab may be more powerful (or perhaps different) from a younger adult's, leading to differences in PM performance. That is, perhaps the reason why younger adults tend not to have superior PM once they leave the lab is because they are not sufficiently motivated to do so. Aberle, Rendell, Rose, McDaniel, and Kliegel (2010) used the possibility of

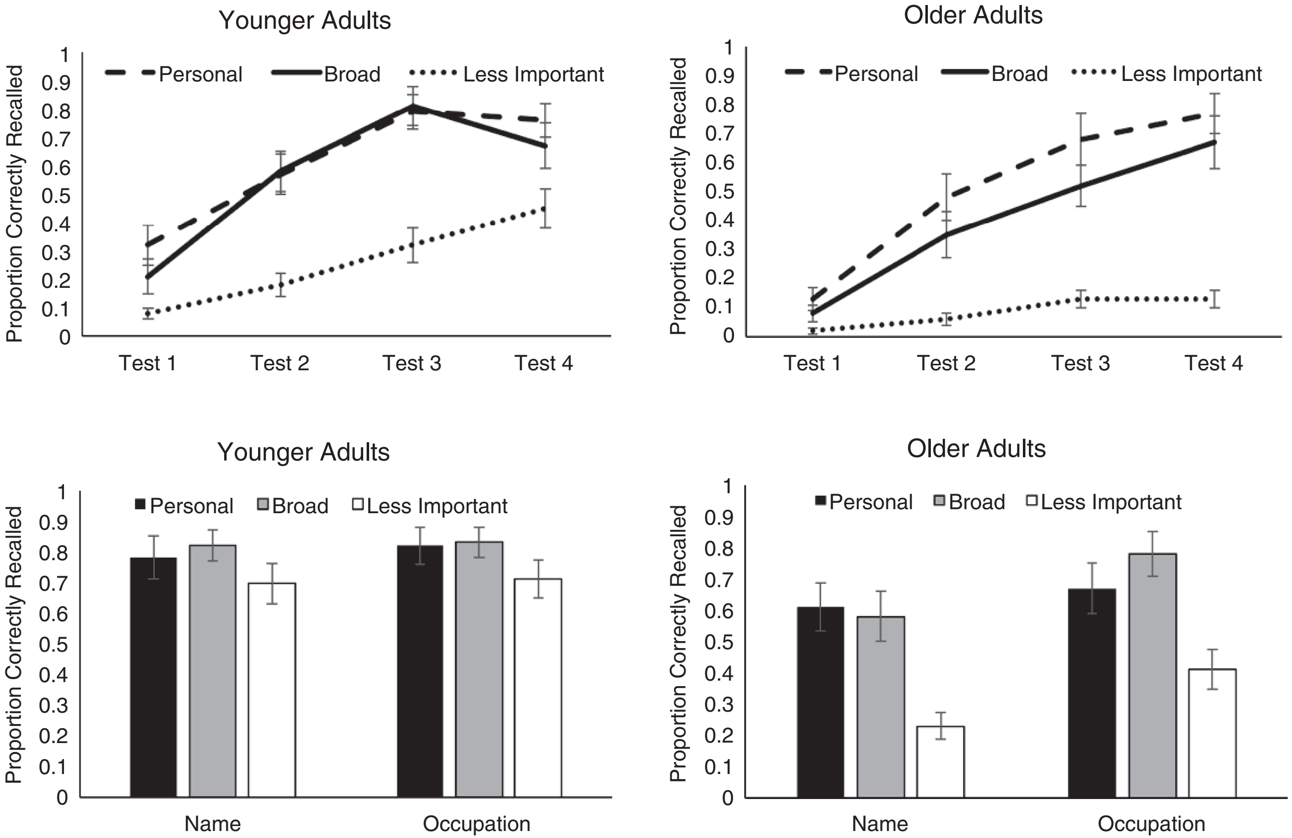

Figure 5.2. The proportion of personally important, broadly important, and less important information correctly recalled by younger adults (left) and older adults (right) in the four free recall tests (top) and final cued recall test (bottom). These results suggest that, given 3 seconds to study each item, participants in both age groups are able to remember the important information with a relatively high level of accuracy, whereas younger adults do perform better than older adults in recalling less important information. Error bars reflect standard error of the mean. Adapted from "Younger and Older Adults' Associative Memory for Social Information: The Role of Information Importance," by M. B. Hargis and A. D. Castel, 2017, *Psychology and Aging*, *32*, p. 327. Copyright 2017 by the American Psychological Association.

winning a small lottery to enhance extrinsic motivation to complete a PM task. There were no age differences in accuracy on this task, but the motivational manipulation led to more accurate performance among younger adults compared with no mention of this lottery, and it did not affect older adults' PM performance. This suggests that older adults' completion of such tasks does not depend on an extrinsic monetary incentive to do so, but younger adults' accuracy benefits from such an incentive.

Curiosity and Other Motivations

An individual's subjective interest in acquiring certain types of information over others is an important motivational factor and should not be overlooked. In fact, age-related memory differences can be overcome—or at least reduced—when older adult participants are interested in the information (see Zacks & Hasher, 2006), possibly related to the reduced load on attentional resources that is needed to study interesting material (McDaniel, Waddill, Finstad, & Bourg, 2000). McGillivray and colleagues (2015) examined how subjective interest and metacognitive judgments related to immediate recall of the to-be-learned information, as well as recall at a 1-week delay. Younger and older adults were presented with trivia questions and asked to indicate which ones they felt confident in answering correctly. Following are three of the trivia questions asked to younger and older adults[1]:

- What is the only planet in our solar system that rotates clockwise?
- What note do most American car horns beep in?
- What world capital city has the fewest cinemas in relation to its population?

Participants were not told in advance of any memory test, only that they were to guess the answers and rate their curiosity and their confidence in knowing the answer. Once the answer was presented, participants rated how interesting they found the information that they learned, as well as how likely they thought they would remember the answer at a later time. At the end of the day's testing session, participants completed a surprise cued recall test on half the questions, in which they were presented with the trivia question and asked to remember the answer, and those who responded incorrectly on a particular question were told the correct answer. After a 1-week delay, participants were tested on the other half of the questions. There were no age-related differences in recall at the immediate test or at the 1-week delay, which was somewhat surprising given prior work showing differential effects of delay on younger and older adults' memory (e.g., Zacks, Radvansky, &

[1]Answers: Venus; F; and Cairo, Egypt.

Hasher, 1996). Overall, performance after a 1-week delay was significantly less accurate than the immediate test, as expected. Interestingly, older adults' recall was more strongly predicted by the ratings they gave after learning the answers to the trivia questions, whereas younger adults' recall was less strongly predicted by this factor. This underscores the importance of interest in older adults' long-term learning of information. Interest may affect attention because resources are diverted away from items in which the participant is not interested and toward more interesting items, which has notable implications for learning in other domains (e.g., learning Spanish for an upcoming trip to South America versus learning Spanish because you read that learning a new language is good for your cognitive health, although these might evoke different levels of interest from different people, based on their goals and prior knowledge).

Loewenstein (1994) argued that a positive relationship between curiosity and knowledge is a major component in establishing expertise in a particular domain because people become "progressively more curious" (p. 94) about the subject matter they are learning. Interest, as explored by Hidi (1990), is not to be underestimated as a motivation for learning new things. In fact, Hidi argued that interest-based activities involve motivation, attention, increased knowledge, and value. Although Hidi noted that applying individual interest in the educational domain by tailoring curricula to students' interests is difficult, interest may be a more applicable tool for an older adult learner who is empowered to seek out information. That is, older adults may benefit by seeking out interesting material because the attentional control problems that they may face in other areas of learning (i.e., information that they are asked to memorize for a laboratory task, which may not inherently interesting to them) may be greatly decreased, thus improving later recall of the information. Relatedly, higher need for cognition, or the extent to which one values and pursues cognitively demanding activities (Cacioppo, Petty, Feinstein, & Jarvis, 1996), is associated with higher levels of cognitive performance in older age (Salthouse, 2014).

Verbal knowledge may be maintained and used effectively in older age; on tests of vocabulary, younger and older adults often perform equally well (Verhaeghen, 2003). This knowledge is often put to use in proofreading e-mails, letters, or other documents, but one's interest in the material being proofread may vary. Hargis et al. (2017) examined younger and older adults' performance on a proofreading task and found that younger and older adults were similarly motivated to perform the task (as measured by self-report Likert-scale ratings) but that older adults found the passages more interesting overall than did younger adults. Neither proofreading accuracy nor comprehension of the text differed between younger and older adults (cf. Connelly, Hasher, & Zacks, 1991; Stine-Morrow, Shake, Miles, & Noh, 2006), suggesting that interest in the materials may play an important role in performing well on this task.

Noting that memory is "extraordinarily complicated" (p. 430), Jenkins (1979) created a model of how discrete aspects of memory experiments can influence performance, with a particular goal of conceptualizing how these variables interacted with one another in the construction and implementation of memory experiments (see also Roediger, 2008). The original Problem Pyramid (see Figure 5.3) contained the following variables: subjects (including one's abilities and knowledge), orienting tasks (including what the experimenter included as instructions and apparatus), materials (including the organization and sequence of stimuli), and criterial tasks (including the

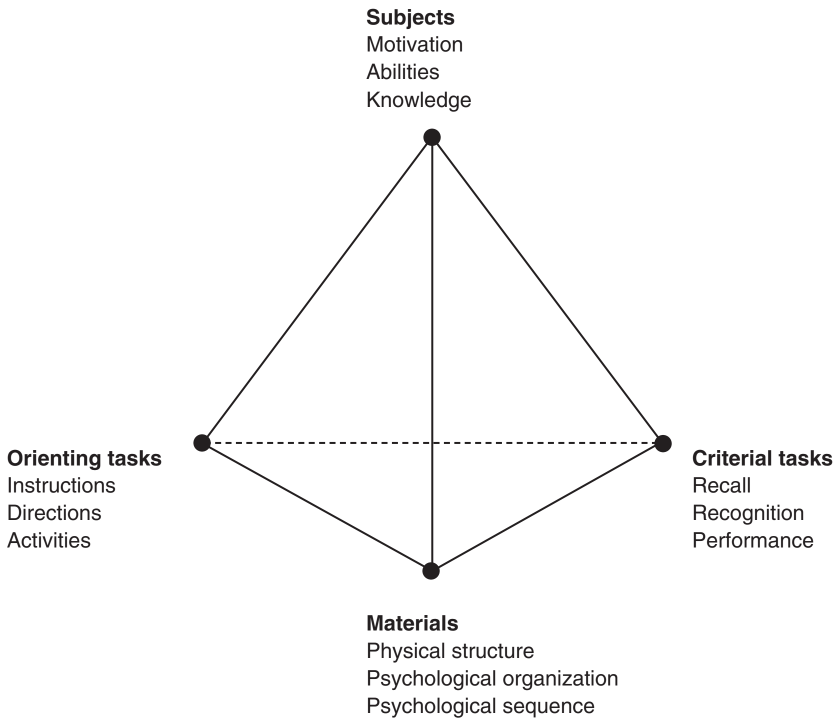

Figure 5.3. Jenkins's (1979) tetrahedral model of memory experiments, adapted to include "Motivation" within the variable "Subjects." Jenkins suggested that the variables at the vertices interact with each other in significant ways and that experimenters should consider them when designing tasks. We suggest that the explicit inclusion of "Motivation" within the variable "Subjects" reflects its importance in the domain of memory and cognitive aging. From "Four Points to Remember: A Tetrahedral Model of Memory Experiments," by J. J. Jenkins, 1979, in L. S. Cermak and F. I. M. Craik (Eds.), *Levels of processing in human memory* (p. 432), 1979, Hillsdale, NJ: Erlbaum. Copyright 2006 by Taylor & Francis. Adapted with permission.

construction of free- and cued-recall tests). Jenkins suggested that these variables interact with each other in meaningful ways and each should be carefully considered when designing memory tasks. This model has not yet been explicitly extended to the study of cognitive aging and how older adults may be motivated in memory experiments. Motivation can vary quasi-experimentally (as younger and older adults may approach tasks with different goals at hand, including knowledge pursuit and emotion regulation), or the experimenter can vary motivation with between- or within-subjects task construction. Emphasizing motivation in the overall "subjects" variable allows for the consideration of motivation as an important interacting factor with performance and for the examination of how motivation interacts with the other variables in the model. We also note that a participant's background, career, and culture may also influence task performance and motivation. Future research exploring the effects of motivational factors on memory may consider this model in guiding research questions and experimental design.

Reward Salience

One factor that motivates younger and older adults alike is the potential of earning a reward. In many cases, the anticipation of obtaining a reward can enhance explicit memory. Prior research has demonstrated that information associated with a reward may be better consolidated in memory through the activation of dopaminergic reward systems in the midbrain and striatum (for a review, see Shohamy & Adcock, 2010). In a typical task investigating the effects of reward salience on memory, younger adults were shown various scenes preceded by a low-value (e.g., \$0.01) or high-value (e.g., \$5.00) reward cue indicating the amount that they could later earn by correctly remembering that scene (Adcock, Thangavel, Whitfield-Gabrieli, Knutson, & Gabrieli, 2006). Participants studied the scenes while neural activity was measured using functional magnetic resonance imaging (fMRI). Results indicated that after a 24-hour delay, participants had better memory for the high-value scenes. Further, during encoding, greater activation in the ventral tegmental area (VTA) in the midbrain, the nucleus accumbens (NAcc) in the ventral striatum, and the hippocampus was associated with those high-value scenes that were later remembered, but not forgotten high-value scenes. These findings suggest that the presence of a high reward may increase activation in the midbrain and striatum, which may in turn enhance memory for associated information by increasing hippocampal dopamine release before the encoding of that information.

Advancing age is linked to a decline in dopaminergic modulation (Bäckman, Nyberg, Lindenberger, Li, & Farde, 2006; Kaasinen et al., 2000), and many of the cognitive impairments associated with age have been associated with a degradation of dopaminergic systems (Volkow et al., 1998). As such, it is important to determine whether the effects of reward as a motivational factor on memory are consistent throughout old age. Spaniol, Schain, and Bowen (2014) examined reward-enhanced memory in the context of aging. Using a similar paradigm to Adcock et al. (2006) in younger and older adults, Spaniol and colleagues found that older adults showed a similar pattern to their younger adult counterparts, remembering more high- than low-value scenes after a 24-hour delay, demonstrating an age-independent effect of reward anticipation on intentional episodic memory formation. Importantly, although no neuroimaging data were obtained in this particular study, the authors considered this evidence for reward-enhanced, hippocampus-dependent memory consolidation persisting into older adulthood.

Further, the activation of dopaminergic reward systems has been proposed as a possible explanation for VDR effects, at least in younger adults. Although the previously discussed research used monetary reward as a motivational factor, other research has demonstrated similar effects using a point-based reward system. Cohen, Rissman, Suthana, Castel, and Knowlton (2014) examined the neural correlates of VDR, using pairs of words and point values that were tested via free recall. Younger adults engaged in a VDR task while undergoing fMRI. Similar to results obtained when using monetary rewards, Cohen and colleagues found greater activation in dopaminergic reward regions (i.e., the VTA and NAcc) on high-value trials, even at immediate testing. These results indicate that episodic memory can benefit from reward anticipation even when there is no opportunity for memory consolidation, as previous work found enhanced memory for high-value information only after a 24-hour delay (Adcock et al., 2006; Spaniol et al., 2014). In addition, there was greater activation in the left ventrolateral prefrontal cortex (VLPFC; an area associated with deep semantic processing) when encoding high-value words and a significant correlation of activity in this area with a measure of memory selectivity, suggesting that explicit use of deep semantic processing strategies may also contribute to the selective encoding of high-value information in the context of this task. The same group of researchers extended this research to aging by including an older adult sample and found that similar semantic processing regions were associated with memory selectivity in older adults but that the pattern of activation in such areas differed from younger adults (Cohen, Rissman, Suthana, Castel, & Knowlton, 2016). Specifically, they found that older adults were less likely to engage areas associated with semantic processing (e.g., the left VLPFC) during the presentation of low-value information, whereas younger adults were more likely to engage these areas during the presentation of high-value information (see Figure 5.4). Interestingly, activation in dopaminergic reward regions was not modulated by the value of information in older adults. These findings

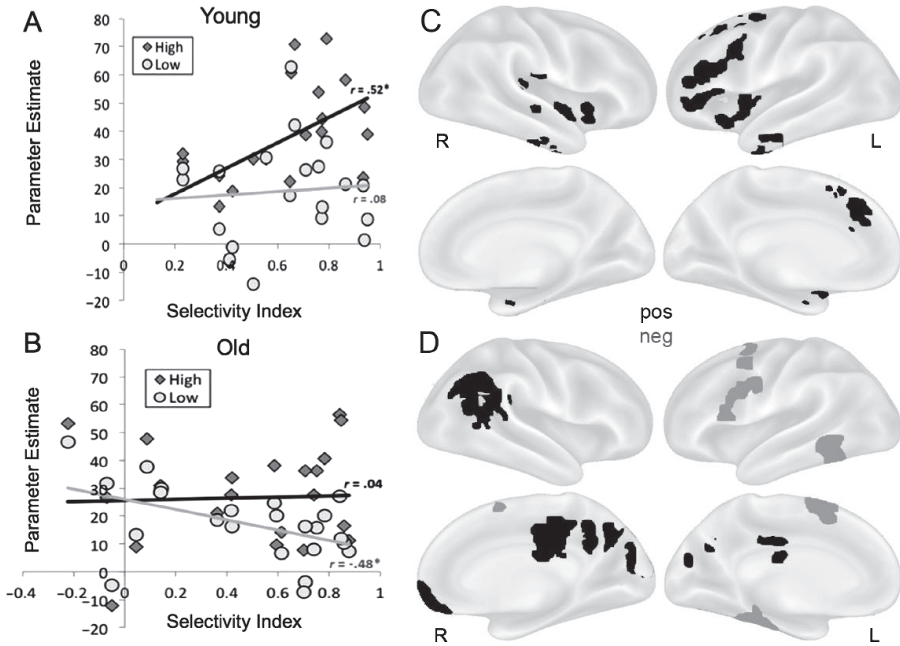

Figure 5.4. Results obtained from younger and older adults on a value-directed remembering task while undergoing functional magnetic resonance imaging depict correlations between a measure of memory selectivity and brain areas associated with semantic processing (i.e., the left ventrolateral prefrontal cortex). On the left, (A) higher memory selectivity in younger adults is associated with higher activation in such areas for high-value but not low-value information, and (B) higher memory selectivity in older adults is associated with lower activation in semantic processing areas for low-value but not high-value information. Activation in dopaminergic reward regions (i.e., the nucleus accumbens and ventral tegmental area) was not significantly modulated by value in older adults. On the right, regions associated with correlations between brain activity during encoding and the selectivity index for (C) high-value information in younger adults and (D) for low-value information in older adults. From "Effects of Aging on Value-Directed Modulation of Semantic Network Activity During Verbal Learning," by M. S. Cohen, J. Rissman, N. A. Suthana, A. D. Castel, and B. J. Knowlton, 2016, *NeuroImage*, *125*, pp. 1055, 1058. Copyright 2016 by Elsevier. Adapted with permission.

highlight the importance of semantic processing areas but call into question the role of dopaminergic reward systems, at least for older adults, in VDR tasks. As such, future research should examine the extent to which activation in dopaminergic reward systems and engagement of frontotemporal regions during explicit strategy use contribute to older adults' selectivity on these reward-based tasks. Given that older adults often show equivalent (or in some cases, enhanced) selectivity on VDR tasks (Castel et al., 2002, 2007, 2009), future research should investigate the extent to which activation in dopaminergic reward systems and engagement of frontotemporal regions during explicit strategy use contribute to older adults' selectivity on these reward-based tasks.

MOTIVATION AND MAKING DECISIONS

To achieve our goals, we must make a series of decisions (e.g., deciding to enroll in a class at a local community college to learn a new language with the ultimate goal of communicating, staying cognitively active, or both); the reasons why and the ways in which these decisions are made may change across the lifespan. Although some research has shown that younger and older adults perform equivalently on many decision-making tasks (Kovalchik, Camerer, Grether, Plott, & Allman, 2005), there is also reason to expect that older adults may value time and money differently than younger adults.

Age-related changes in goals influence how we think about the future: Older adults are less likely to commit the sunk cost fallacy (i.e., older participants are not likely to persist with a failed investment; Strough, Mehta, McFall, & Schuller, 2008), which is thought to be related to their limited time horizons and perhaps their tendency to focus on positive, rather than negative, information. Strough et al. (2008) suggested that, due at least in part to this positivity effect, older adults are more likely than younger adults to weigh losses and gains somewhat similarly, thus leading to their lower likelihood of demonstrating the sunk cost fallacy. That is, an older adult is more likely to make the normatively correct decision—for example, spending the same amount of time watching a movie that you do not enjoy whether you paid for it or not.

More recent work suggests that the perception of limited time horizons contributes to this type of decision-making. Strough, Schlosnagle, Karns, Lemaster, and Pichayayothin (2014) limited younger adults' perception of their future time by asking them to imagine having a critical illness that does not allow them much longer to live. This group's decisions about sunk cost scenarios were compared with a group that received an expansive time horizon manipulation and a control group. The participants whose time horizons were limited were significantly less likely to demonstrate the sunk cost fallacy than the expansive and control groups (the lack of difference between the expansive and control groups was explained by noting that younger adults often already have expansive time horizons, and thus the manipulation may not have changed much about their decision-making). Similarly, another study examined older adults' decision-making process when purchasing a new car and found that older adults considered fewer brands, dealers, and models than younger adults and that older adults were more likely to repurchase a brand of car that they had previously owned (Lambert-Pandraud, Laurent, & Lapersonne, 2005). Interpreted via an SST lens (Carstensen et al., 1999), older adults were motivated to repurchase from a particular brand in an effort to maintain and give priority to a close relationship formed with that brand, compared with a new, unfamiliar brand. These findings suggest that the positivity effect and the perceived expansiveness of the future may affect how goals are pursued in a variety of domains.

Prosocial behavior, particularly the giving of time or money, is thought to increase with age and is correlated with well-being across the lifespan (McAdams, de St. Aubin, & Logan, 1993; see also Okun & Schultz, 2003). For older adults, deciding to act prosocially is connected with having a sense of meaning in life (Midlarsky & Hannah, 1989) and is also positively related to social connectedness (Choi & Chou, 2010). Younger adults are often thought to choose to donate time or money because of the personal benefits attained (one can boost one's self-esteem and résumé by volunteering; Choi & Chou, 2010). Bjälkebring, Västfjäll, Dickert, and Slovic (2016) suggested that the motivation to give to charity is motivated at least in part by a positivity bias when considering both past and future donations, such that older adults experience more positivity when giving, and younger adults experience both negative and positive feelings while making decisions about donating. Emotional variables are important in charitable giving but may not entirely explain older adults' decisions, and future research can investigate how, for example, gist-based processing and VDR in older age can affect these decisions (Hargis & Oppenheimer, 2016).

Other research also demonstrates that older adults' decisions about their own health care may be affected by this shift from knowledge acquisition to emotion regulation. Various studies have found that older adults are less likely to request additional information about potential cancer treatment options and make more immediate, less informed decisions both in experimental laboratory scenarios with healthy participants and in actual cancer patient samples (Cassileth, Zupkis, Sutton-Smith, & March, 1980; Meyer, Russo, & Talbot, 1995). These results have been explained, in part, by older adults' tendency to avoid potentially negative knowledge acquisition to maintain emotional well-being (Löckenhoff & Carstensen, 2004). Unsurprisingly, this lack of desire to gain health-related knowledge has been shown to lead to negative health consequences (Morrell, Park, & Poon, 1989; Willis, Dolan, & Bertrand, 1999).

With regard to health-related decision-making, there is also considerable evidence that older adults are more likely to avoid making a decision and instead defer the choice to their physicians or relatives both in laboratory settings (Curley, Eraker, & Yates, 1984; Finucane et al., 2002) and in real-life situations (Beisecker, 1988; Cassileth et al., 1980; Petrisek, Laliberte, Allen,

& Mor, 1997). Given that the decision-making process can elicit negative emotions, especially when the decision has personally relevant consequences (Houston, Sherrill-Mittleman, & Weeks, 2001), it is not surprising that older adults may seek to avoid such processes to maintain successful emotion regulation. It is important to note, however, that this may also represent an adaptive feature of older adults' decision-making, in that they are more likely to delegate a potentially life-dependent decision to someone (e.g., a physician, surgeon, or other health care professional) who has a deeper understanding about the situation and is ultimately more likely to make a beneficial decision.

When older adults do make health-related decisions, however, the manner in which they evaluate their options appears to affect how successful their decisions are. Mikels and colleagues (2010) asked younger and older adults to evaluate and select an option from a list of various fictitious health care options. Each option was presented with a set of attributes, some of which were positive (e.g., "It takes little time to get reimbursed") and some of which were negative (e.g., "No 24-hour phone hotline is available"). In addition to a control group, participants were either instructed to base their decisions on their emotional reactions to the listed options or to base their decisions on the options' specific details. Older adults selected the "better" option (i.e., a higher ratio of positive to negative attributes associated with a particular health care plan, physician, medical treatment, or homecare aid) more frequently in the emotion-focused condition and control conditions, compared with the detail-focused condition. Younger adults, on the other hand, had the best performance in the detail-focused condition.

Other research has demonstrated that focusing on emotional information when making health care decisions may only be beneficial for older adults who themselves are in good health but not for those in poorer health. In a study by English and Carstensen (2015), older adults provided self-report measures of physical health and then reviewed information related to hypothetical health-related decisions (choosing one's physician and health plan) and non–health-related decisions (choosing one's car and neighbor). Each option had characteristics that varied in quality from very good (e.g., very good preventative care associated with a particular health plan) to very poor (e.g., very poor riding comfort associated with a particular car). The results indicated that when making health-related decisions, older adults in good health showed a positivity bias by reviewing more of the positive characteristics, whereas older adults in poor health did not show this bias. Interestingly, this difference in older adults' health did not affect reviewing of characteristics associated with non–health-related decisions, with both groups showing a positivity bias. Taken together, these results suggest that older adults' health-related decision-making may benefit from an emotion-related focus but that personal characteristics such as physical health may also determine what information older adults consider when making health-related decisions.

CONCLUSION

It is clear that as we become older, our motivations and goals tend to change. Underlying much of the research on motivation is the notion that we tend to pursue more socioemotional goals as we age, and with this comes an increase in focusing on positive information (a shift present in memory recall, decision-making, and several other domains). Whereas younger adults may focus more on acquiring knowledge, older adults often seek to build and maintain relationships with loved ones. This pattern is related to a positivity bias in older adults' attention allocation and recall, such that negative information is not often prioritized and positive information is; older adults tend to pursue goals in line with this preference. Not all of older adults' motivations are primarily social and emotional in nature, however; many pursue knowledge for the sake of attaining it or to satisfy their curiosity. Younger and older learners tend be differentially motivated by intrinsic and extrinsic factors, with older learners perhaps more motivated by internal factors (e.g., learning with the goal of challenging themselves) than their younger adult counterparts who may be more motivated by external factors (e.g., learning with the goal of increasing their grade point average). Studies among older undergraduate students and older adults enrolled in lifelong learning programs suggest that learning in a classroom context is appealing to many older people, and perhaps this trend will increase with the increasing accessibility of learning at home via virtual courses given online.

In some goal contexts, it seems that older adults are able to allocate their attention toward information that will help them succeed, even in light of age-related deficits in processing resources. When the information at hand is valuable (e.g., words associated with high point values or social information that we are likely to use again), older adults perform as well as younger adults on recall tests, especially once given task experience. Memory differences are indeed present, such that younger adults often recall more information overall than older adults do, but memory selectivity seems to be possible for older people in several types of tasks.

Certainly, younger and older adults are motivated by a variety of factors to engage in a set of particular behaviors, remember certain information, or make a particular decision. Further research should continue to explore the various intrinsic and extrinsic motivational factors that affect cognition across the lifespan and in what situations these may or may not differ with increasing age. With a greater understanding of the shifts in priorities and goals that occur in later life, we can both further theoretical understanding of cognitive aging and apply this understanding to real-world situations to investigate older adults' cognition in a variety of contexts.

REFERENCES

Aberle, I., Rendell, P. G., Rose, N. S., McDaniel, M. A., & Kliegel, M. (2010). The age prospective memory paradox: Young adults may not give their best outside of the lab. *Developmental Psychology*, *46*, 1444–1453. http://dx.doi.org/10.1037/a0020718

Adcock, R. A., Thangavel, A., Whitfield-Gabrieli, S., Knutson, B., & Gabrieli, J. D. E. (2006). Reward-motivated learning: Mesolimbic activation precedes memory formation. *Neuron*, *50*, 507–517. http://dx.doi.org/10.1016/j.neuron.2006.03.036

Bäckman, L., Nyberg, L., Lindenberger, U., Li, S. C., & Farde, L. (2006). The correlative triad among aging, dopamine, and cognition: Current status and future prospects. *Neuroscience and Biobehavioral Reviews*, *30*, 791–807. http://dx.doi.org/10.1016/j.neubiorev.2006.06.005

Balota, D. A., & Faust, M. E. (2001). Attention in dementia of the Alzheimer's type. In F. Bolla & S. F. Cappa (Eds.), *Handbook of neuropsychology: Vol. 6. Aging and dementia* (2nd ed., pp. 51–80). New York, NY: Elsevier Science.

Barber, S. J., Opitz, P. C., Martins, B., Sakaki, M., & Mather, M. (2016). Thinking about a limited future enhances the positivity of younger and older adults' recall: Support for socioemotional selectivity theory. *Memory & Cognition*, *44*, 869–882. http://dx.doi.org/10.3758/s13421-016-0612-0

Beisecker, A. E. (1988). Aging and the desire for information and input in medical decisions: Patient consumerism in medical encounters. *The Gerontologist*, *28*, 330–335. http://dx.doi.org/10.1093/geront/28.3.330

Bjälkebring, P., Västfjäll, D., Dickert, S., & Slovic, P. (2016, June 15). Greater emotional gain from giving in older adults: Age-related positivity bias in charitable giving. *Frontiers in Psychology, 7*. Retrieved from https://www.frontiersin.org/articles/10.3389/fpsyg.2016.00846/full

Bye, D., Pushkar, D., & Conway, M. (2007). Motivation, interest, and positive affect in traditional and nontraditional undergraduate students. *Adult Education Quarterly*, *57*, 141–158. http://dx.doi.org/10.1177/0741713606294235

Cacioppo, J. T., Petty, R. E., Feinstein, J. A., & Jarvis, W. B. G. (1996). Dispositional differences in cognitive motivation: The life and times of individuals varying in need for cognition. *Psychological Bulletin*, *119*, 197–253. http://dx.doi.org/10.1037/0033-2909.119.2.197

Carstensen, L. L. (1992). Social and emotional patterns in adulthood: Support for socioemotional selectivity theory. *Psychology and Aging*, *7*, 331–338. http://dx.doi.org/10.1037/0882-7974.7.3.331

Carstensen, L. L., & Fredrickson, B. L. (1998). Influence of HIV status and age on cognitive representations of others. *Health Psychology*, *17*, 494–503. http://dx.doi.org/10.1037/0278-6133.17.6.494

Carstensen, L. L., Isaacowitz, D. M., & Charles, S. T. (1999). Taking time seriously. A theory of socioemotional selectivity. *American Psychologist*, *54*, 165–181. http://dx.doi.org/10.1037/0003-066X.54.3.165

Carstensen, L. L., & Mikels, J. A. (2005). At the intersection of emotion and cognition aging and the positivity effect. *Current Directions in Psychological Science*, *14*, 117–121. http://dx.doi.org/10.1111/j.0963-7214.2005.00348.x

Cassileth, B. R., Zupkis, R. V., Sutton-Smith, K., & March, V. (1980). Information and participation preferences among cancer patients. *Annals of Internal Medicine*, *92*, 832–836. http://dx.doi.org/10.7326/0003-4819-92-6-832

Castel, A. D. (2008). The adaptive and strategic use of memory by older adults: Evaluative processing and value-directed remembering. In A. S. Benjamin & B. H. Ross (Eds.), *The psychology of learning and motivation* (Vol. 48, pp. 225–270). London, England: Academic Press.

Castel, A. D., Balota, D. A., & McCabe, D. P. (2009). Memory efficiency and the strategic control of attention at encoding: Impairments of value-directed remembering in Alzheimer's disease. *Neuropsychology*, *23*, 297–306. http://dx.doi.org/10.1037/a0014888

Castel, A. D., Benjamin, A. S., Craik, F. I., & Watkins, M. J. (2002). The effects of aging on selectivity and control in short-term recall. *Memory & Cognition*, *30*, 1078–1085. http://dx.doi.org/10.3758/BF03194325

Castel, A. D., Farb, N. A., & Craik, F. I. (2007). Memory for general and specific value information in younger and older adults: Measuring the limits of strategic control. *Memory & Cognition*, *35*, 689–700. http://dx.doi.org/10.3758/BF03193307

Castel, A. D., Lee, S. S., Humphreys, K. L., & Moore, A. N. (2011). Memory capacity, selective control, and value-directed remembering in children with and without attention-deficit/hyperactivity disorder (ADHD). *Neuropsychology*, *25*, 15–24. http://dx.doi.org/10.1037/a0020298

Charles, S. T., & Carstensen, L. L. (2007). Emotion regulation and aging. In J. Gross (Ed.), *Handbook of emotion regulation* (pp. 307–327). New York, NY: Guilford Press.

Choi, N. G., & Chou, R. J. A. (2010). Time and money volunteering among older adults: The relationship between past and current volunteering and correlates of change and stability. *Ageing & Society*, *30*, 559–581. http://dx.doi.org/10.1017/S0144686X0999064X

Cohen, M. S., Rissman, J., Suthana, N. A., Castel, A. D., & Knowlton, B. J. (2014). Value-based modulation of memory encoding involves strategic engagement of fronto-temporal semantic processing regions. *Cognitive, Affective & Behavioral Neuroscience*, *14*, 578–592. http://dx.doi.org/10.3758/s13415-014-0275-x

Cohen, M. S., Rissman, J., Suthana, N. A., Castel, A. D., & Knowlton, B. J. (2016). Effects of aging on value-directed modulation of semantic network activity during verbal learning. *NeuroImage*, *125*, 1046–1062. http://dx.doi.org/10.1016/j.neuroimage.2015.07.079

Connelly, S. L., Hasher, L., & Zacks, R. T. (1991). Age and reading: The impact of distraction. *Psychology and Aging*, *6*, 533–541. http://dx.doi.org/10.1037/0882-7974.6.4.533

Craik, F. I. M., & Byrd, M. (1982). Aging and cognitive deficits: The role of attentional resources. In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive processes* (pp. 191–211). New York, NY: Plenum.

Curley, S. P., Eraker, S. A., & Yates, J. F. (1984). An investigation of patients' reactions to therapeutic uncertainty. *Medical Decision Making*, *4*, 501–511. http://dx.doi.org/10.1177/0272989X8400400412

Donohue, T. L., & Wong, E. H. (1997). Achievement motivation and college satisfaction in traditional and nontraditional students. *Education*, *118*, 237–243.

Eich, T. S., & Castel, A. D. (2016). The cognitive control of emotional versus value-based information in younger and older adults. *Psychology and Aging*, *31*, 503–512. http://dx.doi.org/10.1037/pag0000106

Einstein, G. O., & McDaniel, M. A. (1990). Normal aging and prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*, 717–726. http://dx.doi.org/10.1037/0278-7393.16.4.717

English, T., & Carstensen, L. L. (2015). Does positivity operate when the stakes are high? Health status and decision making among older adults. *Psychology and Aging*, *30*, 348–355. http://dx.doi.org/10.1037/a0039121

Ersner-Hershfield, H., Mikels, J. A., Sullivan, S. J., & Carstensen, L. L. (2008). Poignancy: Mixed emotional experience in the face of meaningful endings. *Journal of Personality and Social Psychology*, *94*, 158–167. http://dx.doi.org/10.1037/0022-3514.94.1.158

Finucane, M. L., Slovic, P., Hibbard, J. H., Peters, E., Mertz, C. K., & MacGregor, D. G. (2002). Aging and decision-making competence: An analysis of comprehension and consistency skills in older versus younger adults considering health-plan options. *Journal of Behavioral Decision Making*, *15*, 141–164. http://dx.doi.org/10.1002/bdm.407

Friedman, M. C., McGillivray, S., Murayama, K., & Castel, A. D. (2015). Memory for medication side effects in younger and older adults: The role of subjective and objective importance. *Memory & Cognition*, *43*, 206–215. http://dx.doi.org/10.3758/s13421-014-0476-0

Fung, H. H., & Carstensen, L. L. (2003). Sending memorable messages to the old: Age differences in preferences and memory for advertisements. *Journal of Personality and Social Psychology*, *85*, 163–178. http://dx.doi.org/10.1037/0022-3514.85.1.163

Fung, H. H., & Carstensen, L. L. (2004). Motivational changes in response to blocked goals and foreshortened time: Testing alternatives to socioemotional selectivity theory. *Psychology and Aging*, *19*, 68–78. http://dx.doi.org/10.1037/0882-7974.19.1.68

Fung, H. H., Lu, M., & Isaacowitz, D. M. (2018). Aging and attention: Meaningfulness may be more important than valence. *Psychology and Aging*. Advance online publication. http://dx.doi.org/10.1037/pag0000304

Hargis, M. B., & Castel, A. D. (2017). Younger and older adults' associative memory for social information: The role of information importance. *Psychology and Aging*, *32*, 325–330. http://dx.doi.org/10.1037/pag0000171

Hargis, M. B., & Castel, A. D. (2018). Younger and older adults' associative memory for medication interactions of varying severity. *Memory*, *26*, 1151–1158. http://dx.doi.org/10.1080/09658211.2018.1441423

Hargis, M. B., & Oppenheimer, D. M. (2016, July 14). Commentary: Greater emotional gain from giving in older adults: Age-related positivity bias in charitable giving. *Frontiers in Psychology*, *7*, 1075. http://dx.doi.org/10.3389/fpsyg.2016.01075

Hargis, M. B., Yue, C. L., Kerr, T., Ikeda, K., Murayama, K., & Castel, A. D. (2017). Metacognition and proofreading: The roles of aging, motivation, and interest. *Neuropsychology, Development, and Cognition: Section B. Aging, Neuropsychology and Cognition*, *24*, 216–226. http://dx.doi.org/10.1080/13825585.2016.1182114

Heckhausen, J., & Schulz, R. (1995). A life-span theory of control. *Psychological Review*, *102*, 284–304.

Hidi, S. (1990). Interest and its contribution as a mental resource for learning. *Review of Educational Research*, *60*, 549–571. http://dx.doi.org/10.3102/00346543060004549

Houston, D. A., Sherrill-Mittleman, D., & Weeks, M. (2001). The enhancement of feature salience in dichotomous choice dilemmas. In E. U. Weber & J. Baron (Eds.), *Conflict and tradeoffs in decision making* (pp. 65–85). New York, NY: Cambridge University Press.

Jenkins, J. J. (1979). Four points to remember: A tetrahedral model of memory experiments. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing in human memory* (pp. 429–446). Hillsdale, NJ: Erlbaum.

Kaasinen, V., Vilkman, H., Hietala, J., Någren, K., Helenius, H., Olsson, H., . . . Rinne, J. (2000). Age-related dopamine D2/D3 receptor loss in extrastriatal regions of the human brain. *Neurobiology of Aging*, *21*, 683–688. http://dx.doi.org/10.1016/S0197-4580(00)00149-4

Kan, I. P., Garrison, S. L., Drummey, A. B., Emmert, B. E., Jr., & Rogers, L. L. (2018). The roles of chronological age and time perspective in memory positivity. *Neuropsychology, Development, and Cognition: Section B. Aging, Neuropsychology and Cognition*, *25*, 598–612. http://dx.doi.org/10.1080/13825585.2017.1356262

Kim, A., & Merriam, S. B. (2004). Motivations for learning among older adults in a learning in retirement institute. *Educational Gerontology*, *30*, 441–455. http://dx.doi.org/10.1080/03601270490445069

Kovalchik, S., Camerer, C. F., Grether, D. M., Plott, C. R., & Allman, J. M. (2005). Aging and decision making: A comparison between neurologically healthy elderly and young individuals. *Journal of Economic Behavior & Organization*, *58*, 79–94. http://dx.doi.org/10.1016/j.jebo.2003.12.001

Lambert-Pandraud, R., Laurent, G., & Lapersonne, E. (2005). Repeat purchasing of new automobiles by older consumers: Empirical evidence and interpretations. *Journal of Marketing*, 69, 97–113. http://dx.doi.org/10.1509/jmkg.69.2.97.60757

Löckenhoff, C. E., & Carstensen, L. L. (2004). Socioemotional selectivity theory, aging, and health: The increasingly delicate balance between regulating emotions and making tough choices. *Journal of Personality*, *72*, 1395–1424. http://dx.doi.org/10.1111/j.1467-6494.2004.00301.x

Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin*, *116*, 7–98. http://dx.doi.org/10.1037/0033-2909.116.1.75

Mather, M., & Carstensen, L. L. (2003). Aging and attentional biases for emotional faces. *Psychological Science*, *14*, 409–415. http://dx.doi.org/10.1111/1467-9280.01455

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences*, *9*, 496–502. http://dx.doi.org/10.1016/j.tics.2005.08.005

Mather, M., & Knight, M. (2005). Goal-directed memory: The role of cognitive control in older adults' emotional memory. *Psychology and Aging*, *20*, 554–570. http://dx.doi.org/10.1037/0882-7974.20.4.554

Mather, M., Knight, M., & McCaffrey, M. (2005). The allure of the alignable: Younger and older adults' false memories of choice features. *Journal of Experimental Psychology: General*, *134*, 38–51. http://dx.doi.org/10.1037/0096-3445.134.1.38

McAdams, D. P., de St. Aubin, E., & Logan, R. L. (1993). Generativity among young, midlife, and older adults. *Psychology and Aging*, *8*, 221–230. http://dx.doi.org/10.1037/0882-7974.8.2.221

McDaniel, M. A., Waddill, P. J., Finstad, K., & Bourg, T. (2000). The effects of text-based interest on attention and recall. *Journal of Educational Psychology*, *92*, 492–502. http://dx.doi.org/10.1037/0022-0663.92.3.492

McDowd, J. M., & Shaw, R. J. (1999). Attention and aging: A functional perspective. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (2nd ed., pp. 221–292). Mahwah, NJ: Erlbaum.

McGillivray, S., & Castel, A. D. (2017). Older and younger adults' strategic control of metacognitive monitoring: The role of consequences, task experience and prior knowledge. *Experimental Aging Research*, *43*, 233–256. http://dx.doi.org/10.1080/0361073X.2017.1298956

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

Meyer, B. J. F., Russo, C., & Talbot, A. (1995). Discourse comprehension and problem solving: Decisions about the treatment of breast cancer by women across the life span. *Psychology and Aging*, *10*, 84–103. http://dx.doi.org/10.1037/0882-7974.10.1.84

Meyer, D. K., & Turner, J. C. (2006). Re-conceptualizing emotion and motivation to learn in classroom contexts. *Educational Psychology Review*, *18*, 377–390. http://dx.doi.org/10.1007/s10648-006-9032-1

Midlarsky, E., & Hannah, M. E. (1989). The generous elderly: Naturalistic studies of donations across the life span. *Psychology and Aging*, *4*, 346–351. http://dx.doi.org/10.1037/0882-7974.4.3.346

Mikels, J. A., Löckenhoff, C. E., Maglio, S. J., Goldstein, M. K., Garber, A., & Carstensen, L. L. (2010). Following your heart or your head: Focusing on emotions versus information differentially influences the decisions of younger and older adults. *Journal of Experimental Psychology: Applied*, *16*, 87–95. http://dx.doi.org/10.1037/a0018500

Minear, M., & Park, D. C. (2004). A lifespan database of adult facial stimuli. *Behavior Research Methods, Instruments, & Computers*, *36*, 630–633. http://dx.doi.org/10.3758/BF03206543

Morrell, R. W., Park, D. C., & Poon, L. W. (1989). Quality of instructions on prescription drug labels: Effects on memory and comprehension in young and old adults. *The Gerontologist*, *29*, 345–354. http://dx.doi.org/10.1093/geront/29.3.345

Naveh-Benjamin, M. (2000). Adult age differences in memory performance: Tests of an associative deficit hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*, 1170–1187. http://dx.doi.org/10.1037/0278-7393.26.5.1170

Okun, M. A., & Schultz, A. (2003). Age and motives for volunteering: Testing hypotheses derived from socioemotional selectivity theory. *Psychology and Aging*, *18*, 231–239. http://dx.doi.org/10.1037/0882-7974.18.2.231

Petrisek, A. C., Laliberte, L. L., Allen, S. M., & Mor, V. (1997). The treatment decision-making process: Age differences in a sample of women recently diagnosed with nonrecurrent, early-stage breast cancer. *The Gerontologist*, *37*, 598–608. http://dx.doi.org/10.1093/geront/37.5.598

Phillips, L., Henry, J., & Martin, M. (2008). Adult aging and prospective memory: The importance of ecological validity. In M. Kliegal, M. McDaniel, & O. Einstein (Eds.), *Prospective memory: Cognitive, neuroscience, developmental, and applied perspectives* (pp. 161–186). New York: Erlbaum.

Pintrich, P. R., Smith, D. A., Garcia, T., & McKeachie, W. J. (1991). *A manual for the use of the Motivated Strategies for Learning Questionnaire (MLSQ)*. Ann Arbor: University of Michigan, National Center for Research to Improve Postsecondary Teaching and Learning.

Roediger, H. L., III. (2008). Relativity of remembering: Why the laws of memory vanished. *Annual Review of Psychology*, *59*, 225–254. http://dx.doi.org/10.1146/annurev.psych.57.102904.190139

Salthouse, T. A. (1995). Processing capacity and its role on the relations between age and memory. In F. E. Weinert & W. Schneider (Eds.), *Memory performance and competencies: Issues in growth and development* (pp. 111–125). Hillsdale, NJ: Erlbaum.

Salthouse, T. A. (2014). Correlates of cognitive change. *Journal of Experimental Psychology: General*, *143*, 1026–1048. http://dx.doi.org/10.1037/a0034847

Schnitzspahn, K. M., Scholz, U., Ballhausen, N., Hering, A., Ihle, A., Lagner, P., & Kliegel, M. (2016). Age differences in prospective memory for everyday life intentions: A diary approach. *Memory*, *24*, 444–454. http://dx.doi.org/10.1080/09658211.2015.1018276

Shohamy, D., & Adcock, R. A. (2010). Dopamine and adaptive memory. *Trends in Cognitive Sciences*, *14*, 464–472. http://dx.doi.org/10.1016/j.tics.2010.08.002

Siegel, A. L. M., & Castel, A. D. (2018). Memory for important item-location associations in younger and older adults. *Psychology and Aging*, *33*, 30–45. http://dx.doi.org/10.1037/pag0000209

Spaniol, J., Schain, C., & Bowen, H. J. (2014). Reward-enhanced memory in younger and older adults. *The Journals of Gerontology: Series B. Psychological Sciences and Social Sciences*, 69, 730–740. http://dx.doi.org/10.1093/geronb/gbt044

Stine-Morrow, E. A., Shake, M. C., Miles, J. R., & Noh, S. R. (2006). Adult age differences in the effects of goals on self-regulated sentence processing. *Psychology and Aging*, *21*, 790–803. http://dx.doi.org/10.1037/0882-7974.21.4.790

Strough, J., Mehta, C. M., McFall, J. P., & Schuller, K. L. (2008). Are older adults less subject to the sunk-cost fallacy than younger adults? *Psychological Science*, *19*, 650–652. http://dx.doi.org/10.1111/j.1467-9280.2008.02138.x

Strough, J., Schlosnagle, L., Karns, T., Lemaster, P., & Pichayayothin, N. (2014). No time to waste: Restricting life-span temporal horizons decreases the sunk-cost fallacy. *Journal of Behavioral Decision Making*, *27*, 78–94. http://dx.doi.org/10.1002/bdm.1781

Vansteenkiste, M., Simons, J., Lens, W., Soenens, B., Matos, L., & Lacante, M. (2004). Less is sometimes more: Goal content matters. *Journal of Educational Psychology*, 96, 755–764. http://dx.doi.org/10.1037/0022-0663.96.4.755

Verhaeghen, P. (2003). Aging and vocabulary scores: A meta-analysis. *Psychology and Aging*, *18*, 332–339. http://dx.doi.org/10.1037/0882-7974.18.2.332

Volkow, N. D., Gur, R. C., Wang, G. J., Fowler, J. S., Moberg, P. J., Ding, Y. S., . . . Logan, J. (1998). Association between decline in brain dopamine activity with age and cognitive and motor impairment in healthy individuals. *The American Journal of Psychiatry*, *155*, 344–349.

Watkins, M. J., & Bloom, L. C. (1999). *Selectivity in memory: An exploration of willful control over the remembering process*. Unpublished manuscript.

Willis, S. L., Dolan, M. M., & Bertrand, R. M. (1999). Problem solving on health-related tasks of daily living. In D. C. Park & R. W. Morrell (Eds.), *Processing of medical information in aging patients: Cognitive and human factors perspectives* (pp. 199–219). Mahwah, NJ: Erlbaum.

Wolfgang, M. E., & Dowling, W. D. (1981). Differences in motivation of adult and younger undergraduates. *The Journal of Higher Education*, *52*, 640–648. http://dx.doi.org/10.2307/1981772

Wrosch, C., Scheier, M. F., Miller, G. E., Schulz, R., & Carver, C. S. (2003). Adaptive self-regulation of unattainable goals: Goal disengagement, goal reengagement, and subjective well-being. *Personality and Social Psychology Bulletin*, *29*, 1494–1508. http://dx.doi.org/10.1177/0146167203256921

Zacks, R., & Hasher, L. (2006). Aging and long-term memory: Deficits are not inevitable. In E. Bialystok & F. I. Craik (Eds.), *Lifespan cognition: Mechanisms of change* (pp. 162–177). New York, NY: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780195169539.003.0011

Zacks, R. T., Radvansky, G., & Hasher, L. (1996). Studies of directed forgetting in older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*, 143–156. http://dx.doi.org/10.1037/0278-7393.22.1.143