Motivated Memory for What Matters Most: How Older Adults (Selectively) Focus on Important Information and Events Using Schematic Support, Metacognition, and Meaningful Goals

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Abstract

Aging is associated with declines in cognitive functioning and memory; however, research has shown that older adults can and do compensate for these declines in a variety of ways. In the present chapter, we discuss various theories of motivational shifts in older adulthood, older adults' ability to selectively remember important information, and the importance of prior knowledge in the ability to compensate for declines in memory and cognition as a result of aging. Older adults can also use their metacognitive awareness to engage in strategies to improve memory for goal-specific information by selectively allocating attentional resources to what is most important. Intrinsic motivational influences on memory and cognition, such as emotion and curiosity, are also discussed. We present an overview of how metacognition, curiosity, emotion, goals, and strategic encoding can bias and enhance memory selectivity such that older adults are often tuned to remember what is most important.

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As people get older, there are changes and declines in memory and cognitive abilities, including a general slowing of cognitive functions (Salthouse, 1996), declining episodic memory (Park et al., 2002), and lower working memory capacity (McCabe et al., 2010; see Harada et al., 2013; Murman, 2015; Salthouse, 2010 for reviews of age-related cognitive decline). Additionally, older adults (typically considered as those over the age of 65) are generally worse than younger adults at remembering associative information which involves the binding of two or more pieces of information (e.g., Bender et al., 2010; Hara & Naveh-Benjamin, 2015; Naveh-Benjamin, 2000; Old & Naveh-Benjamin, 2008; Silver et al., 2012). For example, remembering people's names is a form of associative memory, and forgetting names is a top complaint amongst older adults (see Ginó et al., 2010; Ossher et al., 2013). Older adults also struggle to remember source information – a form of associative memory that involves remembering the context in which an item was learned (Cansino et al., 2013; Park & Puglisi, 1985; Schacter et al., 1991; Spaniol & Grady, 2012). As a result, older adults may be more likely to remember a fact that they heard, but may forget or even misremember where they heard it (Old & Naveh-Benjamin, 2008; Simons et al., 2004). For example, if one learns some false or misleading information from an unreliable source, such as a friend's Facebook post, but thinks they read it in the New York Times, they may believe that information to be true, and this may be especially likely for older adults (Brashier & Schacter, 2020).

While cognitive decline as a product of healthy aging has been well-documented, research has also focused on the aspects of memory that remain intact with older age and ways in which older adults compensate for memory deficits. For example, when presented with large amounts of information, older adults are often able to selectively focus on what is most important (e.g., Castel, 2008). In addition, research suggests that older adults are aware of their memory abilities and often use strategies or control processes to effectively compensate for specific declines (e.g., Castel et al., 2015). Other work has demonstrated that while older adults may not be as good as younger adults at retaining specific information in some cases, they can successfully extract the gist (e.g., the main idea or category information), which is often useful in everyday situations (Earles et al., 1999; Wilhelms et al., 2014). Older adults may also be motivated to remember certain kinds of information over others, and this may be a result of the perceived cognitive costs associated with remembering (Hess, 2014). For example, health and financial information can be confusing and overwhelming, but older adults are able to remember the critical information (e.g., Middlebrooks et al., 2016). In addition, the names of important people are better remembered than the names of less important people (Hargis & Castel, 2017). Even weather forecasts and grocery information may be better remembered by older adults when they can extract gist-based information (Flores et al., 2017; Gallo et al., 2019). Thus, despite declines in memory capacity, older adults are often able to remember important and meaningful information, and this may be due to changes in motivation throughout the aging process.

This chapter will review several theories of cognitive aging with a focus on motivational and goal shifts. We will also discuss how older adults are able to use strategies and metacognition to remember high-value information and retain knowledge about their memory abilities, even though many of these abilities decline. Lastly, we will discuss how other intrinsic motivational factors, like interest, curiosity, and emotion or emotional goals may influence memory as we age. Implications for everyday life and general theories of motivation will also be discussed.

General Theories of Motivational Shifts in Healthy Aging

A few existing theories propose motivational and goal shifts in healthy aging and outline how these shifts can influence cognitive processes like attention and memory. Some argue that emotion regulation goals shift and influence motivation in older age, while others posit that older adults focus on minimizing losses in everyday functioning and adjust goals to account for declines in memory capacity.

Socioemotional Selectivity Theory

Socioemotional selectivity theory (SST; Carstensen et al., 2003, 1999) posits that as people age, their time perspective becomes more limited, and they begin to focus on more emotionally meaningful goals and shift away from longer-term, future-oriented goals. For example, older adults may prioritize balancing emotional states and maintaining close relationships, while younger adults often focus on seeking new knowledge. This focus on emotional goals in older age is thought to lead to more immediate payoffs, which are prioritized given older adults' more limited time, whereas knowledge acquisition tends to help optimize long-term outcomes, which may be more beneficial for younger adults.

SST has been supported by findings showing that older adults tend to prioritize meaningful relationships over meeting new people (e.g., Fung & Carstensen, 2006). For example, one study demonstrated that older adults preferred an advertisement with a slogan focusing on meaningful relationships (i.e., "capture those special moments"), whereas younger adults preferred an advertisement that focused on exploring and gaining new experiences (i.e., "capture the unexplored world"; Fung & Carstensen, 2003). Another study examined the importance of various social partners across age groups before and after the September 11th attacks in New York City, when people presumably felt that their time perspective was more limited (as often happens after major incidents and disasters). Prior to the attacks, a greater proportion of older adults reported wanting to spend time with close partners (i.e., family) than younger adults. However, after the attacks, this proportion was similar for both age groups, suggesting younger adults' priorities became more like those of older adults (Fung & Carstensen, 2006). This finding suggests that a limited time perspective may be a major contributor to the shift toward emotionally meaningful goals in older age. Further, work has shown that older adults primed to think about an expanded time perspective (i.e., that there is a new drug that will allow them to live 20 years beyond the age they expected to live or to be 120) show both social preferences (Fung & Carstensen, 2003) and memory for emotional information (Barber et al., 2016) that are more like that of younger adults, demonstrating more emotion regulation goals over knowledge acquisition goals. SST thus suggests that changing emotional goals across the lifespan contribute to changes in motivation, which can influence cognitive resources and how they are allocated in older age.

Selective Optimization with Compensation Model

Another prominent theory of age-related changes in goals and motivation is the Selective Optimization with Compensation (SOC) model (Baltes, 1997; Baltes & Baltes, 1990; Freund & Baltes, 2000). This model was proposed as a domain-general hypothesis to explain changes in activity engagement, motivation, and cognitive functioning. It posits that older adults experience a decline in resource availability (e.g., cognitive resources, physical functionality) and adjust their expectations and goals in order to optimize outcomes while compensating for declines. In other words, older adults may engage in behaviors that maximize quality of life and ensure that their needs are met while using strategies to compensate for declines, such as external physical aids or cognitive strategies. Importantly, the availability of resources may determine whether one's goals are more focused on growth or gains, maintaining functioning, or minimizing losses. Whereas younger adults tend to report greater growth-oriented goals, older adults report greater maintenance or loss prevention goals (Ebner et al., 2006). This often results in outcomes that may be reduced but still effective in everyday life.

SOC can be applied to many domains, including cognition: given fewer cognitive resources, older adults may selectively allocate cognitive resources (e.g., attention) to information that will yield the most optimal outcome (e.g., remembering the most important information). For example, according to SOC, an older adult who is presented with 10 items to remember, but who only has the capacity to remember three or four items, should focus on remembering the three or four most important items to maximize the benefit. Indeed, ample evidence demonstrates that older adults do perform in this way (e.g., Castel, 2008; Siegel & Castel, 2018). Older adults may also use strategies that focus on loss prevention and maintaining functioning, whereas younger adults tend to be more focused on gains (Freund, 2008). In support of this argument, Freund (2006) found that younger adults were more motivated to continue engaging in a cognitive task when the task focused on optimizing their performance than when it focused on compensating for a loss, whereas older adults persisted longer with the task when compensating for losses.

When making decisions, older adults have been shown to search less information, take longer to process information, and use less cognitively effortful strategies than younger adults, but still make decisions adaptively that are just as good as younger adults' decisions (Mata et al., 2007). Thus, although older adults have fewer resources to attribute to decision-making (a complicated cognitive task), they adaptively adjust their goals and behaviors to result in an optimal decision.

Selective Engagement Theory

Recent work has proposed that due to older adults' declining cognitive resources, they may be more selective with what they choose to use their limited resources for, known as the selective engagement theory (Hess, 2014). This theory is discussed in greater detail in Chapter 2 of this book but we discuss it briefly here as well, as it is an influential perspective on motivational shifts with age. In this view, the cognitive costs (e.g., fatigue) of engaging in cognitively demanding tasks are perceived as greater by older adults than younger adults because of a reduction in resources. Because of the greater costs, the self-relevant benefits of performing a cognitively-demanding activity weigh heavier when deciding whether to engage with a task, and older adults are thus more selective in their activities. For example, younger adults may be willing to engage in a cognitively demanding task because it isn't too tiring or effortful for them to do so. Older adults, on the other hand, may be more reluctant unless there is considerable benefit to them – either intrinsic (e.g., interest or satisfaction from engaging in the task) or extrinsic (e.g., monetary value, evaluation). Indeed, a longitudinal study found that motivation mediated the relationship between declines associated with typical aging and later cognitive abilities like working memory and speed of processing (Hess et al., 2012). Thus, motivational factors likely play an important role when examining cognitive functioning in older adults in laboratory-based tasks.

A consequence of this age-related motivational difference is that older adults may have the capacity to perform at a similar level as younger adults on some tasks, but do not engage the needed cognitive resources to do so unless sufficiently motivated. For example, one study found that older adults show lower performance than younger adults on a cognitive task, but when told their answers would be judged on accuracy by other participants, they performed just as well as younger adults (Hess et al., 2001). Another study found that older adults performed better on a prospective memory task (e.g., remembering to do something in the future) when they thought they were doing the experimenter a favor than when completing the task as usual, suggesting the importance of social motivation on cognitive performance (Altgassen et al., 2010). This motivational aspect of performance is not only important for understanding extant cognitive aging findings, but also for researchers designing tasks to test cognitive abilities with older adults in lab settings. More specifically, it may be useful for researchers to assess how likeable and difficult a task is for older and younger adults, as age-related differences in performance could be accounted for, at least partially, by motivational differences.

Older Adults Selectively Remember Important Information

A few of the theories described previously suggest that older adults are more selective with their cognitive resources, and this may be particularly true when information varies in value or importance. Indeed, much research has examined the influence of value on memory performance in younger and older adults (see Castel, 2008; Castel et al., 2012 for overviews). A general paradigm has been developed to study memory for information of varying importance, known as the value-directed remembering (VDR) paradigm. In the VDR paradigm, participants study one or more lists of at least 10 or 12 items – typically words. Each word is paired with a point value, which indicates the number of points participants will receive if the item is correctly recalled or recognized on a later test. Participants are instructed that their goal is to maximize their point score (see Figure 1A).

Participants' recall performance is then used to calculate a "selectivity index," which compares a participant's total point score relative to an ideal score (e.g., the best possible point score based on number of words recalled). For example, a participant who remembers only four words but these are the four highest value words (i.e., 9-, 10-, 11-, and 12-point words) would receive a perfect selectivity score. On the other hand, a participant who remembers eight words, but the responses include low-value words (e.g., 1- or 2-point words), would receive a lower selectivity score. Thus, regardless of the *amount* of information remembered, the selectivity index gives a measure of how successfully participants use their memory capacity to focus on important information and achieve task goals.

While older adults consistently show worse overall memory performance in VDR tasks (i.e., remember fewer words), they often have just as high or even higher selectivity scores as younger adults (Ariel et al., 2015; Castel, 2008; Castel et al., 2002, 2011; Hennessee et al., 2017; Siegel & Castel, 2019; Swirsky & Spaniol, 2019). In other words, older adults generally prioritize recall of the highest-value items relative to low-value items (see Figure 1B).

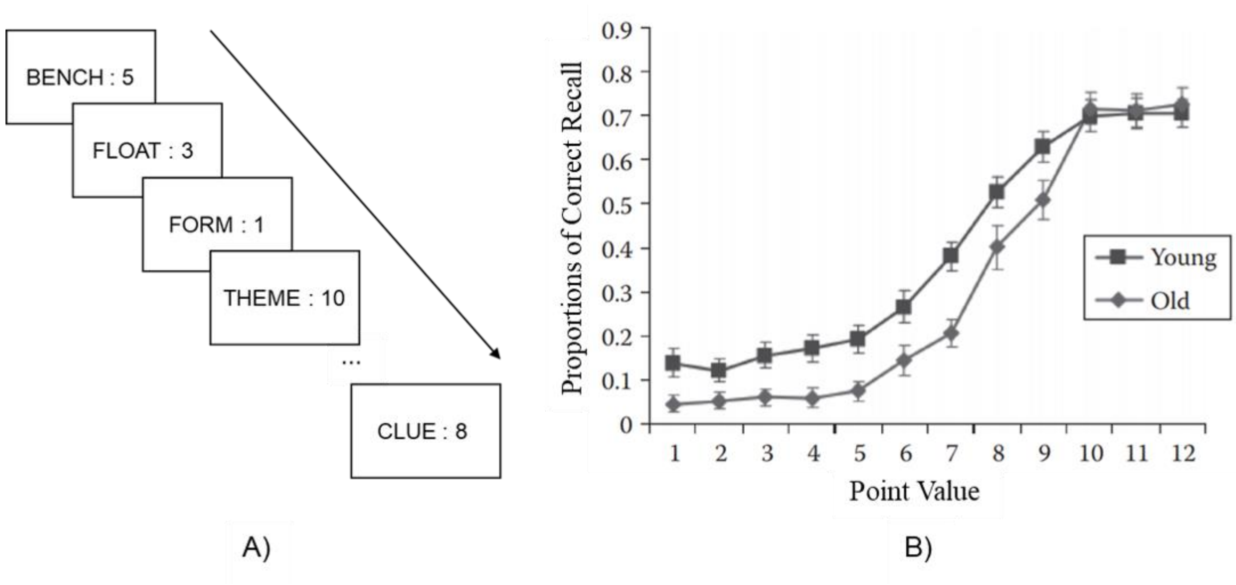

Figure 1. Value-Directed Remembering Procedure and Results. Panel A shows a typical value-directed remembering (VDR) paradigm with word stimuli. Panel B shows recall results as a

function of age and point value. The data show no age-related differences in recall for high-value items (i.e., 10-, 11-, and 12-point words), but age-related differences exist for lower-value items. (Adapted from Castel, 2008; Castel, et al., 2002).

VDR tasks have been used to study selectivity in not only word recall tasks, but also with item-location pairs (Siegel & Castel, 2018) and images (DeLozier & Rhodes, 2015). In addition, age-related differences in selectivity seem to hold whether using point scores or monetary values (e.g., Spaniol et al., 2014). These findings suggest that, regardless of the details of the task, older adults experience reductions in capacity but are able to use their cognitive resources selectively to achieve goals by attending to and remembering the most important information.

More recent work has examined the influence of value on memory for information that is not associated with an objective point value but is subjectively important to participants. For example, one study instructed participants to imagine that they would be doing an activity (e.g., going camping, going on vacation, taking a picnic, etc.) and needed to remember the items to bring (McGillivray & Castel, 2017). Items varied in terms of how useful they were for the given activity, but could all be considered relevant. Participants assigned point values to each item presented, and then received the number of points they had assigned if they correctly recalled the item on a later test. Consistent with previous findings, older adults were able to successfully remember the most important information, even though points were not objectively assigned by the experimenter.

In addition to prioritizing subjectively important information, older adults have been shown to better remember high-value information in more naturalistic categories. For example, older adults are able to remember critical health information (e.g., important side effects of a medication or severe food allergies) over less critical information, and perform similarly to younger adults with task practice (Friedman et al., 2015; Middlebrooks et al., 2016). Hargis and Castel (2017) further demonstrated that older adults can successfully remember important social information. They showed younger and older adults faces, names, and occupations (e.g., your new doctor, future actor) of various people that participants were told to imagine they were meeting at a party, along with information about the likelihood of participants interacting with those people in the future. For example, “your new doctor” would be categorized as “definitely will interact with in the future” whereas “sales clerk” would be categorized as “will never interact with again.” After studying 20 people, participants were tested on each person’s name and occupation. The results revealed that younger adults remembered the same amount of information about the important and less important people, but older adults remembered more information about the important people (see Figure 2).

Together, these findings suggest that, across multiple domains and with varying paradigms and types of stimuli, age-related differences in memory are reduced or even eliminated for the most important information. This supports theories of motivation that suggest older adults are able to selectively allocate resources or update goals to maximize outcomes and compensate for reductions in resources (consistent with SOC and selective engagement theory discussed earlier).

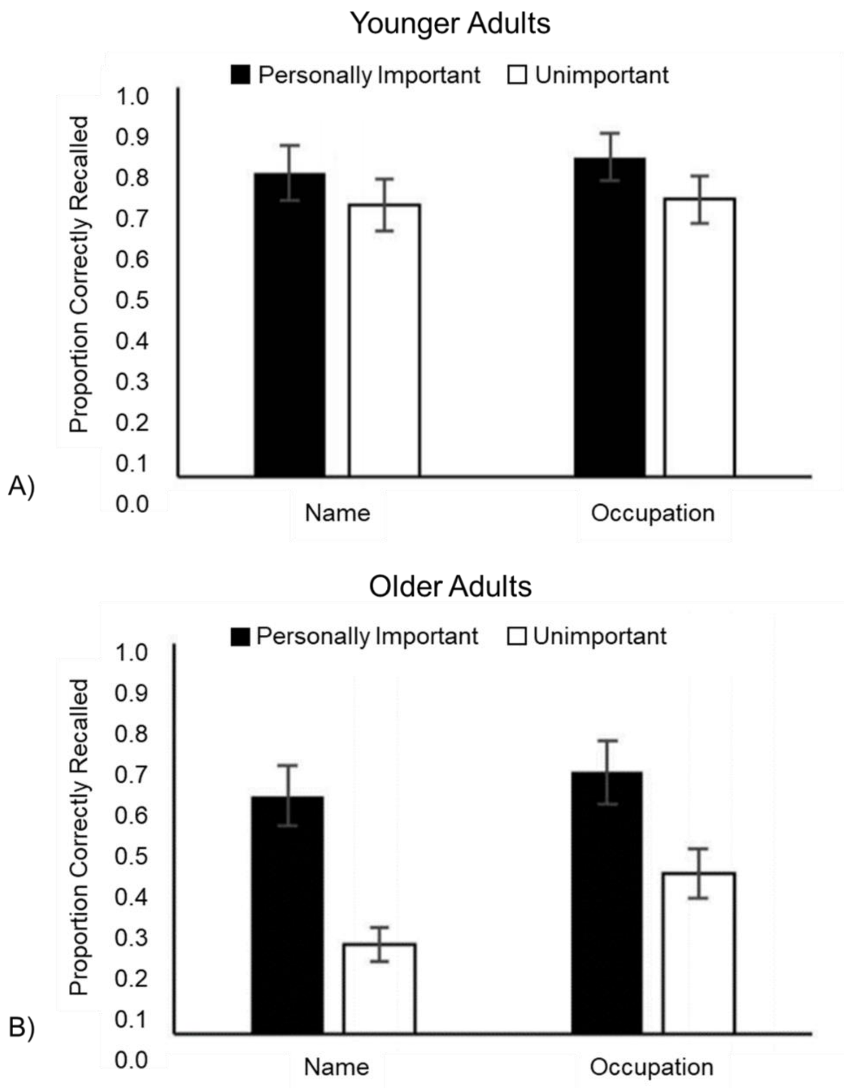

Figure 2. Memory for Important and Unimportant People. Panel A shows recall performance for names and occupations of faces that represent personally important or unimportant people for younger adults. Panel B shows older adult performance. Younger adults remember as much information about unimportant as important people, while older adults selectively remember more information about important people (Adapted from Hargis & Castel, 2017).

Older Adults Rely on Prior Knowledge to Improve Memory

In addition to better remembering important information over unimportant information, some evidence suggests information that is consistent with prior knowledge and expectations may be better remembered than more unrealistic or meaningless information in older age (see Umanath & Marsh, 2014 for a review). A variety of studies have demonstrated an associative deficit in older age, in which older adults struggle to bind two or more pieces of information in memory more than to remember single items alone (Bender et al., 2010; Naveh-Benjamin, 2000; Old & Naveh-Benjamin, 2008; Silver et al., 2012). However, when information can be incorporated into a general schema (i.e., a mental representation of a concept), that information is better remembered, particularly for older adults (Castel, 2005; Umanath & Marsh, 2014). This phenomenon has been termed *schematic support* (Craik & Bosman, 1992) and has been demonstrated using a variety of stimuli (e.g., Naveh-Benjamin et al., 2003, 2004; Rhodes et al., 2008). In one study, younger and older adults studied grocery items that were paired with either realistic (i.e., market value) prices or were overpriced and were then asked to remember the exact price of the items (Castel, 2005). Younger adults performed better than older adults when remembering the overpriced items, but older adults were just as good as younger adults at remembering the realistically priced items (see Figure 3). Thus, older adults' schematic knowledge of the general price of grocery items (e.g., that bread costs about $2) was associated with better memory for information consistent with that schema. Recent work has replicated and extended these findings (Amer et al., 2018; Fine et al., 2018; Kuhns & Touron, 2019; Mohanty et al., 2016), and even demonstrated that younger adults benefit from schematic support as well, though not to the same extent (Kuhns & Touron, 2019).

Research has also demonstrated that older adults are better able to remember gist-based information, even when unable to remember the specific details. For example, one study presented participants with grocery items and their prices, but each item-type (e.g., orange juice, pasta) appeared twice with different brand names (Flores et al., 2017). Participants then attempted to recall the exact prices of the items as well as which was a "better buy." Older adults struggled to remember the specific information but were as good as younger adults at remembering the gist information (i.e., which brand was a better buy). Other work suggests that schematic knowledge influences the ability to correctly recognize pictures as belonging to a category – a type of gist-based memory (Deason et al., 2012). While superior memory for gist-based information in older age has been shown to lead to greater endorsement of false information (Devitt & Schacter, 2016; Gutchess & Schacter, 2012; Koutstaal & Schacter, 1997), it may also allow older adults to extract the overall needed information (e.g., Adams et al., 1997) in order to make decisions and otherwise function in daily life.

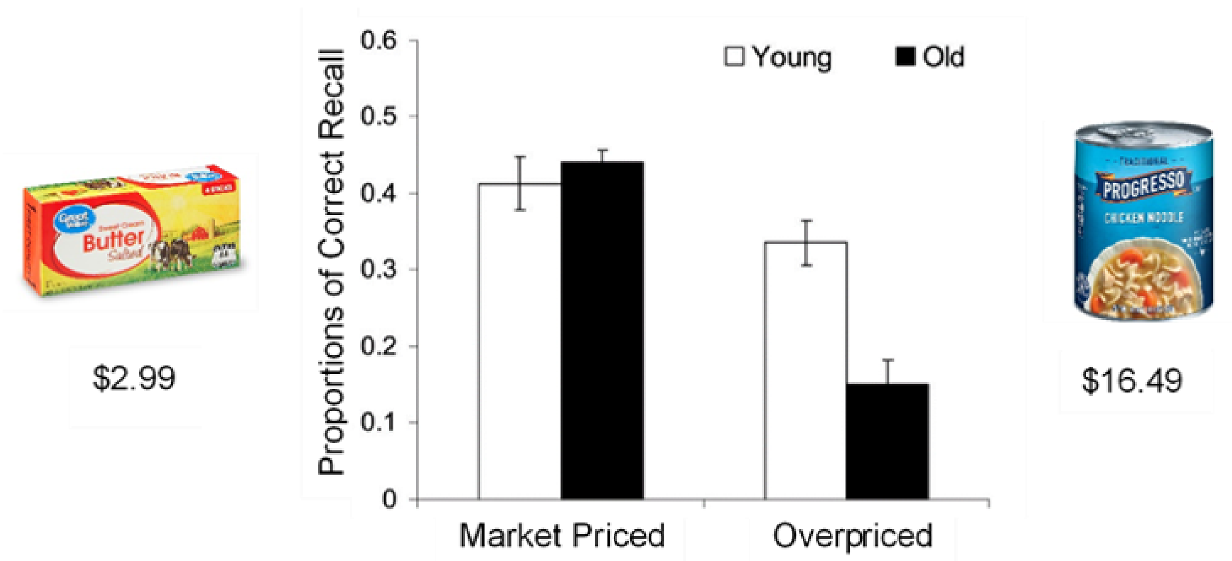

Figure 3. Schematic Support for Grocery Items. In the typical grocery prices paradigm, participants study market priced items (e.g., "butter $2.99," as shown on the left) and overpriced items (e.g., "soup $16.49," as shown on the right). While age-related differences in recall were evident for overpriced items, there were no differences in memory for market priced items. (Adapted from Castel, 2005).

While schematic support seems to be beneficial for memory performance with many types of stimuli and paradigms, it is largely unknown why this is the case. One possibility is a difference in motivation. For example, participants may be more interested in or motivated to remember realistic information and, therefore, may ignore the more arbitrary information. Some have also argued that the activation of schemas allows for less reliance on effortful, self-initiated processing (Soederberg Miller, 2009). For example, one study demonstrated that activating a schema prior to encoding resulted in better memory performance for information that fit with that schema (Besken & Gülgöz, 2009). In addition, research examining neural mechanisms of schemas has shown that activating schemas leads to the engagement of specific areas of the brain – specifically, the ventromedial prefrontal cortex (vmPFC; Gilboa & Marlatte, 2017), which have been shown to be active during encoding of schema-consistent information but not during encoding of arbitrary information (Spalding et al., 2015). This pattern of neural activation suggests the recruitment of unique neural resources during schema-consistent encoding.

In addition to differential encoding processes for schema-consistent versus inconsistent information, some work also suggests that retrieval processes may contribute to the memory benefits of schematic support in older adults. One study using the grocery prices paradigm described in Castel (2005) and mentioned previously demonstrated that schema-consistent information is better remembered when under time pressure at retrieval (Amer et al., 2018). This suggests that retrieving information that is consistent with prior knowledge may require less cognitive control during retrieval or could potentially be more automatic. In addition, activation of schema networks has been shown during retrieval of schema-consistent information, but not during retrieval of arbitrary information (Webb & Dennis, 2018). In all, activating schemas engages neural resources that may help facilitate the binding of information in memory with less strategic, controlled processing at both the encoding and retrieval time points.

The Role of Meaningfulness

Regardless of the mechanism by which schematic support improves memory, schema-consistent information may be more meaningful than inconsistent or arbitrary information for both younger and older adults. Indeed, some have argued that realistic grocery prices are meaningful, whereas arbitrary ones are not, highlighting the correlative nature of meaningful and familiar information (e.g., Amer et al., 2018). As an example, a realistic cereal price may lead to deeper processing, such as relating the price to what one typically pays for cereal, noting which brands may be more expensive than others, or evaluating whether each item could be on sale or from an expensive grocery store. An overpriced item, however, may lead participants to simply categorize the item as "too high" and stop allocating additional cognitive resources to encode the price. Recent work also suggests that both prior knowledge and meaningfulness work to improve memory performance in older adults (Skinner & Price, 2019).

Aside from schema-consistent information, other information deemed to be meaningful to participants also tends to be better remembered. For example, one study found that age-related differences in memory were reduced for pictures rated as personally relevant to participants than those rated as irrelevant (Tomaszczyk et al., 2008). Older adults have also been shown to be just as good as younger adults at remembering gist-based weather information (e.g., whether it would be rainy or sunny), despite forgetting more specific details (e.g., the temperature or exact chance of rain; Gallo et al., 2019). Furthermore, one study demonstrated that older adults who endorse emotionally meaningful goals allocate more attention to socially meaningful faces, regardless of emotional valence (Fung et al., 2018). Together, these findings demonstrate the importance of meaningfulness in understanding how schematic support and emotion influence memory.

Metacognition and Strategy Use in Older Age

Although older adults are able to remember important, schema-consistent, and meaningful information quite well, they do generally demonstrate poorer memory performance than younger adults. However, understanding whether older adults are aware of memory declines and are able to use strategies to compensate is, perhaps, more important to everyday functioning than simply understanding memory in old age. Some difficulty addressing this awareness arises from the many ways to measure metacognition, which is the knowledge about one's own learning or memory. Some methods assess metacognitive accuracy at the encoding stage (i.e., when studying an item) wherein participants judge the likelihood of remembering the presented information on a later test (typically on a percentage or probability scale), known as a judgment of learning (JOL; see Rhodes, 2016 for a review). These judgments are then compared to actual performance to calculate metacognitive accuracy. Other judgments, like confidence judgments (CJs) are made at retrieval and can show different patterns in metacognitive accuracy as compared to JOLs (e.g., Siedlecka et al., 2016).

Metacognitive judgments like JOLs are impacted by a variety of factors, such as how concrete or abstract a word is (Tauber & Rhodes, 2012), emotional valence (Groninger, 1976; Tauber & Dunlosky, 2012; Zimmerman & Kelley, 2010), and visual appearance (Rhodes & Castel, 2008; Yue et al., 2013). In other words, JOLs can be influenced by many item-level cues that are often – but not always – good indicators of future remembering. However, some evidence suggests that JOLs become more accurate with multiple study-test trials or opportunities to learn about performance (Castel et al., 2013; McGillivray & Castel, 2017). Interestingly, some recent work has found that the act of making JOLs can influence memory performance, known as reactivity, by leading participants to think critically about the studied information (Mitchum et al., 2016; Soderstrom et al., 2015). However, in a series of experiments, Tauber and Witherby (2019) demonstrated age-related differences in JOL reactivity, such that older adults' memory performance was *not* influenced by making JOLs, but younger adults' memory was consistently influenced by making JOLs. It is worth noting that both younger and older adults do successfully calibrate their JOLs with increased task experience (e.g., Tauber &

Rhodes, 2012), but this improved calibration may not influence actual performance for older adults as it does for younger adults.

Because of the variability and relative inaccuracy of immediate JOLs made without feedback or task experience (Rhodes, 2016), some studies use delayed JOLs, which are JOLs made some time after the initial presentation of an item, but still before retrieval (Nelson & Dunlosky, 1991; see Rhodes & Tauber, 2011b for a meta-analysis). Delayed JOLs tend to lead to less overconfidence than immediate JOLs, and many have suggested that this is due to participants engaging in retrieval practice when making these judgments (Dunlosky & Nelson, 1992; Nelson & Dunlosky, 1991; Rhodes & Tauber, 2011a). Like delayed JOLs, CJs (made after retrieval) tend to be more accurate than immediate JOLs (Siedlecka et al., 2016). However, they do not give information about the perceived difficulty of items at encoding, which could influence how participants engage in strategies or control.

There have been mixed results regarding the accuracy of JOLs, CJs, and delayed JOLs in older age (Dodson et al., 2007; Eakin et al., 2014; Halamish et al., 2011; Hansson et al., 2008). Despite declines in actual memory performance with age, one study using a lifespan sample of adults showed that JOL accuracy actually remains relatively stable in older age (Hertzog et al., 2010; Hertzog & Dunlosky, 2011). Although older adults generally rely on many of the same cues as younger adults when making metacognitive judgments (Connor et al., 1997; Hines et al., 2009; Rast & Zimprich, 2009), there are some age-related differences. For example, older adults tend to give more accurate local judgments (i.e., item-by-item) but are less accurate at global judgments relative to younger adults (i.e., predicting how many items out of the total they will remember; Siegel & Castel, 2019). In addition, when participants make judgments that are more like bets (i.e., participants gain or lose the value they assign to each item) and there are consequences for forgetting, older adults are actually more metacognitively accurate than younger adults at first, and both age groups become more accurate with task experience (Figure 4; McGillivray & Castel, 2017).

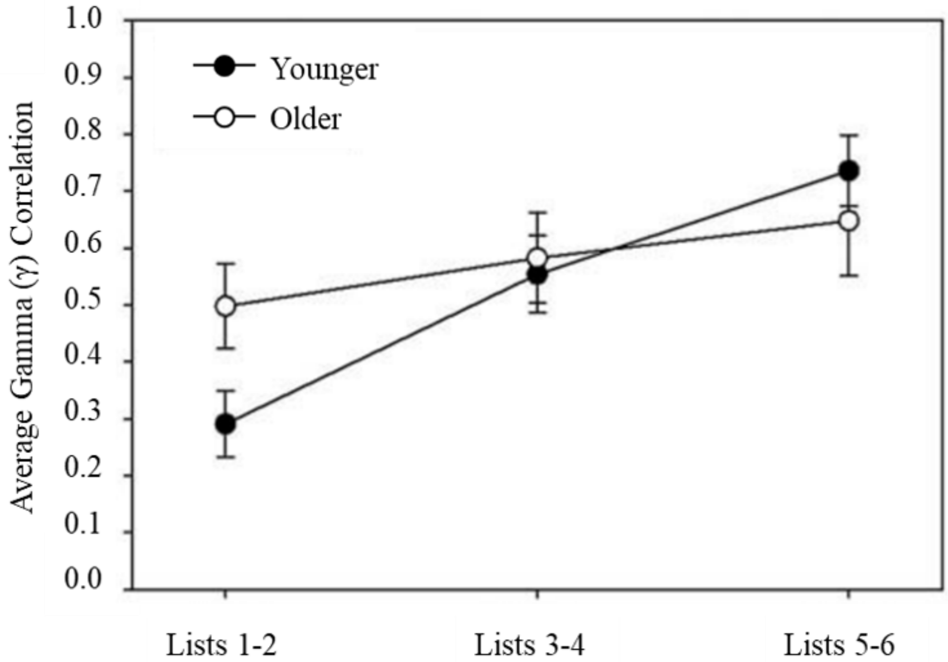

Figure 4. Metacognitive Accuracy with Task Experience. Participants assigned a value to each item, which served as a bet (e.g., they gained the value they had assigned if the item was correctly remembered, but lost the value if they forgot). Gamma correlations represent the relative accuracy of the assigned values. Both younger and older adults became more metacognitively accurate with greater task experience. (Adapted from McGillivray & Castel, 2017).

Strategy Use and Strategic Metacognitive Control in Older Age

Given that older adults' metacognitive accuracy may often be intact (e.g., Hertzog & Dunlosky, 2011), older adults should be able to effectively engage in metacognitive control processes (i.e., the processes that regulate cognition and behavior; Nelson, 1996). However, older adults do not always spontaneously use strategies that result in successful retrieval (Bouazzaoui et al., 2010; Rogers et al., 2000). First, a distinction should be drawn between strategy use and strategic metacognitive control. Strategies refer to specific ways of encoding information that aids in the later remembering of that information (see Bouazzaoui et al., 2010; Lemaire, 2010 for examples). Importantly, we are referring to internal strategies, rather than actions taken to reduce memory load, such as offloading behaviors (e.g., writing down things you might forget or setting a reminder). These internal strategies include (but are not limited to) rote rehearsal (i.e., repeating the item over and over), imagery (i.e., visualizing the item and sometimes including sensations such as smell or touch), sentence generation (i.e., creating a sentence using a presented word), and relating the information to oneself or a memorable situation. Some strategies are known to be more effective than others, and this can depend on the type of stimuli. For example, for younger adults visual imagery was found to be more effective than rehearsal when the text was presented orally, but rehearsal was more effective when the text was presented in written form (de Beni & Moè, 2003).

Studies examining age-related differences in strategy use have found that older adults report using strategies like imagery and sentence generation (effective, elaborative strategies) much less than younger adults, but report using rote rehearsal (a largely ineffective strategy) more often (e.g., Bouazzaoui et al., 2010). While older adults are less likely to use effective strategies than younger adults, they can successfully use strategies when explicitly instructed to do so. One study showed that when instructed to use effective strategies at encoding and retrieval, older adults overcame their associative deficit (Naveh-Benjamin et al., 2007). In addition, some work suggests older adults can learn to utilize effective strategies given task experience (Hertzog et al., 2012), indicating that older adults are able to use strategies to improve performance, but may not do so spontaneously.

Strategic control, also referred to as metacognitive control, is less well-defined than strategies, but tends to be considered any cognitive processes that regulate cognition (e.g., attentional or memory processes) or behavior. Strategic control generally captures the extent to which one engages with certain items, the amount of cognitive and attentional resources allocated to items, and the amount of effort given to specific items. Thus, factors like information importance or general motivation can influence the allocation of cognitive resources. In addition, strategic control can be influenced by metacognitive judgments (e.g., JOLs; see Nelson, 1996). For example, items deemed to be more important or more difficult may be given more attentional resources, which might include using effective strategies. On the other hand, less important items or items deemed likely to be remembered may be ignored or participants may rehearse other items during their presentation.

One way to assess metacognitive control is with self-paced or self-regulated study. In these paradigms, participants may study each item as long as they wish, sometimes with a cutoff (self-paced study), or may select which items to study and how many times to study each item, as well as how long (self-regulated study). While these measures do not assess the use of particular strategies, they do allow researchers to measure to which items participants allocate more resources, allowing researchers to draw inferences about information importance, difficulty, and other metacognitive factors.

Studies using self-paced or self-regulated study have demonstrated that older adults can use intact metacognitive monitoring abilities to engage in control processes and improve associative memory performance, given multiple study-test trials (Dunlosky et al., 2003). Therefore, older adults may learn to more effectively utilize study time with increased task experience. Another study showed that both younger and older adults strategically varied study time by focusing on the most valuable information, and this increase in study time for high-value items resulted in greater memory performance for those items, especially in older adults (Castel et al., 2013). These findings suggest that while older adults may not engage in effective strategy use, they are able to strategically allocate cognitive resources to improve memory performance.

Intrinsic Motivational Influences on Memory and Cognition Across the Lifespan

As we have discussed, age-related shifts in goals, information importance, prior knowledge, and meaningfulness can influence motivation and, subsequently, memory performance in older age. Here we discuss other intrinsic factors that may serve as motivational influences on cognitive engagement and memory performance across the lifespan.

Emotion

Contrary to the stereotype that older adults are often grouchy or grumpy (e.g., Hummert et al., 1995), people tend to experience negative emotions less frequently throughout adulthood (e.g., Carstensen et al., 2000). As such, research has revealed age-related differences in the relative preference for positively and negatively valenced information. For example, when presented with positive and negative material, compared to younger adults, older adults often spend more time looking at, process a greater portion of, and better remember positive emotional information (or less negative information) whereas the prioritization of negative emotional information is often more pronounced in younger adults (Charles et al., 2003; Isaacowitz et al., 2006, 2006, 2009; Mather & Carstensen, 2003, 2005). This so-called positivity effect refers to a change from a negativity bias at a younger age to a relative preference for positive information that emerges in middle and late adulthood (Carstensen, & Mikels, 2005; Reed et al., 2014).

The positivity effect stems from the socioemotional selectivity theory (SST; Carstensen et al., 1999, 2003), discussed previously, which posits that, throughout life, there is a shift in goals from long-term to more immediate, emotional goals as a function of perceived time perspective. Because goals often direct cognitive resources (Ariel et al., 2009; Dunlosky & Ariel, 2011; Mather & Knight, 2005), people typically show age-related changes in preferences, decisions, and even what they remember as they age. For example, older adults demonstrate the positivity effect in long-term autobiographical memory and can even be biased to misremember the past as more positive (e.g., Kennedy et al., 2004; Mather & Johnson, 2000). Additionally, by utilizing cognitive control processes to achieve emotional goals during encoding, older adults often have enhanced positive and reduced negative information in memory (Mather & Knight, 2005). This strategic allocation of attention likely stems from differences in evaluative processing, the mechanism used to assign value to information, as it is often based on the importance of information relative to the current goals of the individual (e.g., English & Carstensen, 2015; Hess et al., 2001). By preferentially attending to and remembering positive instead of negative information, the positivity effect may play a role in older adults improving their emotional well-being.

While there is much work on the positivity effect, there are some instances in which older adults do not remember or attend to positive over negative information compared to younger adults (e.g., Reed & Carstensen, 2012). For example, recent work suggests that meaningfulness (regardless of emotional valence) may be a stronger influence on attentional resources than emotion, especially for people who endorse emotionally meaningful goals (Fung et al., 2018). Additionally, older adults have been shown to inhibit positive information to remember high-value neutral information (Eich & Castel, 2016). Some have thus argued that older adults prioritize goals that are emotionally meaningful to them, rather than simply always prioritizing positive over negative information (Hess et al., 2017). In support of this argument, one study failed to find the positivity effect in memory for positive versus negative faces but did find an effect when using subjective valence ratings made by participants (Kwon et al., 2009), suggesting the importance of accounting for individual emotional goals.

Curiosity and Interest

Another potential motivational aspect of cognitive aging is how interesting we find the information we are trying to remember or how curious we are, sometimes even about our own memory abilities. General curiosity or an interest in some information can influence motivation in a variety of ways, including willingness to engage with a task, the level of cognitive effort exerted on a task or with certain materials, and even the extent to which older adults participate in various hobbies or everyday activities.

Some work has demonstrated a decline in constructs related to curiosity like openness to experience and novelty seeking with increasing age (Bevins, 2001; Reio & Choi, 2004; Robinson et al., 2017; Steinberg, 2004; but see Giambra et al., 1992). Theories of aging (e.g., socioemotional selectivity theory, mentioned previously) further suggest that curiosity and the desire to learn new information may decline with age as we focus less on knowledge acquisition and more on emotional goals and relationship building, though curiosity can certainly exist within social or emotional domains and future research may address the extent to which curiosity shifts within these domains. In addition, variety-seeking behaviors (i.e., the tendency to try new things for the sake of variety), like seeking new experiences and desire to travel, may decline with age (Roth et al., 2007; Zuckerman et al., 1978; Zuckerman & Neeb, 1980), suggesting that older adults try new things less often and perhaps are less interested in doing so. In line with these findings, older adults tend to consider fewer brands than younger adults (Lambert-Pandraud et al., 2005) and are more loyal to brands they have used for many years, especially in domains like cars or perfumes, though not as much for everyday purchases like toiletries (Evanschitzky & Woisetschläger, 2008; Lambert-Pandraud & Laurent, 2010; Schewe, 1984).

Despite this general decline in curiosity and variety-seeking, maintained curiosity is associated with better memory and well-being (Kashdan, 2009; Sakaki et al., 2018; Stine-Morrow, 2007). One study even showed that higher self-reported trait-level curiosity was associated with greater survival rates over a five-year period in older adults (Swan & Carmelli, 1996). In addition, activities in which older adults report engaging may actually be motivated by interest and curiosity, especially activities that involve learning, as curiosity is related to need for cognition (e.g., the tendency to engage in and enjoy effortful cognitive tasks; Olson et al., 1984). For example, older adults involved in lifelong learning (e.g., taking classes beyond the “typical” college or school age) often report doing so in order to learn new things (Kim & Merriam, 2004; Xiong & Zuo, 2019). Some have thus suggested that curiosity may serve as a protective factor in older age, such that greater levels of curiosity may lead older adults to engage in activities that are good for healthy aging (Sakaki et al., 2018). For example, learning new challenging skills over time, such as photography or a new language, has been shown to improve cognitive functions like episodic memory and speed of processing (Park et al., 2014; see also Chan et al., 2016; Schroeder & Marian, 2012). Although the long-term benefits of this kind of training are unknown, these activities may involve greater interest and curiosity, thus fostering long-term engagement, which may lead to longer-lasting improvements in cognitive functioning.

A general curiosity about memory and the brain in older age have likely contributed to the increased popularity of “brain training” games and programs. A variety of computerized games for cognitive training have been developed in the past decade (e.g., Elevate: www.elevateapp.com; NeuroRacer: Anguera et al., 2013; Lumosity: Hardy et al., 2015).

Although some of these apps or programs have found evidence for improvements in abilities specific to the task, the evidence for long-term retention or transfer of these skills to other domains is weak, according to a meta-analysis (Hampshire et al., 2019). In fact, one study found that commercial cognitive training does not improve scores on standard memory and attention tests any more than playing video games that are not designed to improve cognition (Kable et al., 2017). Thus, brain training may improve one's ability to complete the specific task being trained (i.e., performing crosswords makes one better at crosswords), but they may not help remember, for example, where one left their car keys. Despite the lack of evidence for the efficacy of brain training games, older adults continue to engage in activities for "brain fitness" and spend money in the cognitive training industry, possibly because of curiosity and interest in their own memory abilities or keeping their mind "sharp".

On a smaller scale, interest about specific information may influence memory for that information. Some evidence has shown that interest in studied information can lead to reduced age-related differences in memory performance (Zacks & Hasher, 2006). For example, one study showed that when participants rated trivia questions as more interesting, they were more likely to remember the answers after a week delay, whereas younger adults did not show this relationship to the same extent (McGillivray et al., 2015). Interest in to-be-learned information can even improve memory for incidentally-presented or peripheral information (Gruber et al., 2014), suggesting there may be a more widespread benefit to memory when one is interested in to-be-learned information. McDaniel et al. (2000) suggested that increased interest in the information being studied may reduce the attentional resources required to study and encode that information. As suggested previously, it is also possible that more attentional resources may be allocated to interesting information because it is deemed as more meaningful to the participant. While this has not been largely examined at the task level, these results suggest that tasks completed in the lab that capture the interests of older adults may lead to reduced age-related differences in memory performance.

Conclusion and Implications

As we age, certain memory processes may decline and change such that we can no longer remember as much information as we used to, we process information more slowly, and engaging in cognitively complex tasks may become more effortful and straining. Despite these declines, we may be able to use our spared resources more efficiently to focus on the most important information. Older adults can use knowledge structures that allow for the efficient use of key information and extraction of gist to remember what matters most—and this may differ based on a person’s background, interests, goals and culture. While we have discussed various motivational influences on memory and cognition individually, in everyday scenarios, they likely work together to affect the way we approach, attend to, process, and remember what is needed to maintain functioning in older age.

When it comes to remembering important information, older adults can accomplish their goals in the face of decline in a variety of ways. For example, older adults often selectively focus on and use generally intact metacognitive awareness to focus on the most important information. Meaningful information, including information consistent with our schemas, may even be more important to older adults, leading to differences in the way this information is processed. In addition, factors like curiosity or interest can influence the extent to which older adults engage in activities that may (or may not) improve memory, as well as influence memory for that information. Similarly, emotional information may be processed differently as we get older to align with shifting goals towards increasing emotional well-being.

There are implications of the work described here for interpreting and studying cognitive aging. The differential role of motivation on older and younger adults' performance has often been overlooked when studying memory or attention processes, but researchers should be aware of these differences and design tasks or measure motivation accordingly. In addition, understanding the specific motivational factors (e.g., social, intrinsic) that influence older adults' behavior is becoming increasingly important for understanding existing findings in cognitive aging research. Overall, older adults are able to use spared resources to achieve goals and remember important information in the face of decline by focusing on what matters most. Motivation may be a key factor that allows for "efficient" and selective memory through the strategic use of attention and memory, prior knowledge, and metacognition.

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