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Memory for Allergies and Health Foods:

How Younger and Older Adults Strategically Remember Critical Health Information

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Abstract

Objectives. While older adults often display memory deficits, with practice they can sometimes selectively remember valuable information at the expense of less value information. We examined age-related differences and similarities in memory for health-related information under conditions where some information was critical to remember.

Method. In Experiment 1, participants studied three lists of allergens, ranging in severity from 0 (not a health risk) to 10 (potentially fatal), with the instruction that it was particularly important to remember items to which a fictional relative was most severely allergic. After each list, participants received feedback regarding their recall of the high-value allergens. Experiment 2 examined memory for health benefits, presenting foods that were potentially beneficial to the relative's immune system.

Results. While younger adults exhibited better overall memory for the allergens, both age groups in Experiment 1 developed improved selectivity across the lists, with no evident age differences in severe allergen recall by List 2. Selectivity also developed in Experiment 2, although age differences for items of high health benefit were present.

Discussion. The results have implications for models of selective memory in older age, and for how aging influences the ability to strategically remember important information within health-related contexts.

Keywords: memory, aging, selectivity, health, value-directed remembering,

While memory performance is fallible at any age, older adults typically suffer a pronounced increase in the frequency and range of errors relative to their younger counterparts (Craik, 2002; Hasher & Zacks, 1988; Krueger & Salthouse, 2011). This increase becomes particularly critical when faced with remembering important health information. Older adults often assume the role of caregiver for grandchildren and spouses (Bryson & Casper, 1999; Chen, Mair, Bao, & Yang, 2014; Fuller-Thomson & Minkler, 2001), not to mention caring for themselves. Understanding the impact that normal age-related cognitive changes have on one's ability to remember an ever-increasing amount of medical information is thus important not only in terms of self-care, but also from a caregiving perspective.

Older adults may be able to somewhat compensate for general decreases in overall memory performance by selectively attending to valuable or important information (Baltes & Baltes, 1990; Castel, McGillivray, & Friedman, 2012; Hess, 2005). Engaging in intentional and strategic prioritization of valuable or important information is referred to as value-directed remembering (Castel, 2008; Castel, Benjamin, Craik, & Watkins, 2002). Prior value-directed remembering research has predominantly relied on random, unrelated item-value pairings (e.g., Friedman & Castel, 2013; McGillivray & Castel, 2011), but older adult selectivity and a negation of age-related differences in the recall of high-value items also occurs when using familiar and relatable materials.

For example, recent work suggests that older adults may be able to offset their inability to remember a comprehensive list of side effects by selectively attending to the most severe side effects at the expense of those deemed less severe (Friedman, McGillivray, Murayama, & Castel, 2015). Participants rated a series of side effects for a fictional medication in terms of how unpleasant each would be to experience; unbeknownst to participants, the side effects were

classified a priori as mild, moderate, or severe. After rating their unpleasantness, participants were asked to recall the side effects. Older adult participants remembered more severe side effects (which they rated as most unpleasant) than mild (least unpleasant). Additionally, while expected age-related differences in recall remained for mild side effects, there were no significant age-related differences in the recall of severe side effects, demonstrating that recall differences between the younger and older adults were tempered by older adults' selectivity during study. This suggests that value-directed remembering could be exercised successfully in everyday circumstances, although it does not directly address this issue within a broader health context.

An important question is how selectivity is impacted when value stems from the degree of consequence associated with remembering or forgetting health information. Allergies, for example, are a common affliction and people may have to manage multiple allergies of varying severity (Park, Ahn, & Sicherer, 2010). Food allergies alone result in approximately 30,000 visits to the emergency room annually ("Food Allergies: What You Need to Know," 2010). If caring for a child who is fatally allergic to peanuts and mildly allergic to chocolate, it is more important to remember the peanut allergy than the chocolate allergy when baking cookies. While it sounds simple to remember these two allergies, the task becomes more difficult when considering everything else a caregiver may have to remember at any given point. How does the consequence severity for forgetting impact recall and selectivity?

Declines in memory may be related to the nature of the materials in question. For example, although age discrepancies in recall are consistently apparent for perceptual elements (e.g., a speaker's gender), older adults perform on par with younger adults when recalling *conceptual* elements (e.g., a statement's truthfulness) (Rahhal, May, & Hasher, 2002). This

seemingly maintained ability to remember conceptual particulars is further strengthened by emotional components (May, Rahhal, Berry, & Leighton, 2005). Conceptual elements may be more likely to provide schematic support, from which older adults have been shown to greatly benefit (see Umanath & Marsh, 2014 for a recent review).

When remembering health information in general, older adults may benefit from relevant prior knowledge or experiences. In the case of multiple to-be-remembered elements of varying importance, however, this schematic support could also lead to an increase in item-consequence confusability. Younger adults, for instance, more accurately remembered which side effects warranted a call to the doctor if experienced than did older adults (Freidman et al., 2015). If presented with an allergen of low consequence and another of high consequence, it is imperative to accurately remember which allergen leads to anaphylaxis and which to an itchy nose. When presented with numerous allergens, greater schematic support for an allergen of low consequence could interfere with any attempt to selectively learn and ultimately recall high severity allergens.

Experiment 1

Experiment 1 presents a situation in which younger and older adult participants have just learned of a young relative's newly identified allergies, with exposure resulting in consequences ranging from not severe (e.g., mild itching) to extremely severe, even fatal. Based on prior value-directed remembering research (Castel et al., 2012; Friedman et al., 2015), there was reason to suspect that participants would demonstrate selective study, recalling more severe allergens than mild allergens. Furthermore, health-related information may be more survival-relevant, which could lead to memory benefits via survival processing (cf. Kang, McDermott, & Cohen, 2008).

On the other hand, given the general familiarity people now have with allergies and their prevalence, selectivity attempts might actually be thwarted. Nuts and shellfish, for example, are

well-known allergens; individual reactions to these allergens vary, however, with some patients exhibiting mild reactions and others severe reactions to the same allergen. If older adults rely heavily on schematic support in order to remember the presented allergens, they may be more likely to remember those allergens with which they are most familiar, regardless of the severity of the associated reaction, than those allergens to which their fictional relative is most allergic. Thus, successful engagement in value-directed remembering might be minimized, and age-related differences in the recall of allergens might be present. While reliance on schematic support has been shown to aid older adults' recall in certain situations (Loaiza, Rhodes, & Anglin, 2013; Umanath & Marsh, 2014), doing so in the current experiment could be detrimental should high-value allergens be forgotten in favor of any low-value allergens with which a participant happens to be more familiar.

Methods

Participants

Participants consisted of 24 older adults (13 female) and 24 younger adults (21 female). Younger adult participants were undergraduate students at the University of California, Los Angeles, ranging in age from 17 to 28 years ($M = 20.46$, $SD = 2.17$). Older adult age ranged from 62 to 83 years ($M = 74.62$, $SD = 6.14$), with years of education ranging from 12 (3 high school graduates) to 16+ (10 graduate degrees). Older adult participants were Los Angeles area residents, recruited via fliers posted throughout the community and through the UCLA Cognition and Aging Laboratory participant pool. Younger adult participants received partial credit for a course requirement, while older adult participants received monetary compensation ($10 per hour) for their participation.

Materials

Stimuli consisted of 36 common allergens (e.g., peanut, shellfish, corn) accounting for up to 90% of all food, dermatological, and seasonal allergies ("Allergies", 2014; "Food allergies," 2010). The allergens were divided across 3 lists. Values were divided into three bins consisting of four allergens apiece: low severity (0-3), medium severity (4-7), and high severity (8-10). Each of the 36 allergens was counterbalanced across 3 conditions such that each allergen appeared in each value bin across participants (e.g., throughout the experiment, "mold" was a low-, medium-, and high-value allergen at some point). The order of the allergen presentation was also shuffled in order to avoid effects of either primacy or recency for any specific allergens. Items averaged to a 7.63 ($SD = 1.23$) on the log-transformed Hyperspace Analogue to Language (HAL) frequency scale[1] and ranged from 4.49 to 9.79 (Lund & Burgess, 1996).

Procedure

Participants were asked to imagine that a visiting young relative had recently undergone a series of allergy tests, so it was imperative that the participant remember her newly discovered sensitivities. Participants studied 3 lists, one at a time, with each list containing 12 novel allergens. Within each list, the allergens were presented sequentially for 3 seconds apiece. Each of the allergens were paired with a value, ranging from 0 to 10, expressing the increasing severity of the reaction associated with that allergen. A 0 indicated that the relative could come into contact with the allergen without experiencing any consequences, and 10 indicated that the allergen would lead to a severe, potentially fatal, reaction. Two allergens within each list were paired with a value of 10; all other values featured once per list.

Participants were provided with specific examples of reactions (e.g., anaphylactic shock) resulting from contact with the allergens. In addition to explaining the significance of individual

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[1] The Log HAL frequency measure of the words included in the English Lexical Project ranges from 0 to 17, with an average frequency of 6.16 and a standard deviation of 2.40 (Balota et al., 2007).

ratings, the experimenter also provided gist-based descriptions of low-, medium-, and high-severity reactions (e.g., "A severity value between 8 and 10 indicates that your relative is *severely* allergic to this item. Ingestion of or contact with this item could result in hives and difficulty breathing (8), anaphylactic shock (9), or death (10)"), which may be more congruent with older adults' inclination towards gist-based processing (Craik, 2002; Koutstaal & Schacter, 1997; Tun, Wingfield, Rosen, & Blanchard, 1998). While participants were instructed to remember as many of the allergens as possible, the experimenter also emphasized that it was especially important to remember the most severe allergens, as "remembering what could result in a trip to the hospital is obviously more important than remembering what might make your relative sneezy or gassy." At the conclusion of each list, participants attempted to recall all of the 12 allergens that they could remember before receiving feedback on their recall of the 4 high-severity allergens (e.g., "You left out poppy seeds, which was rated 8, so your relative probably had hives and difficulty breathing.").

Feedback was provided specifically for high-value items to underscore the severe consequences associated with having forgotten those particular allergens. Also, any consequences associated with forgetting low- or medium-value allergens become irrelevant in light of high-value forgetting: if the young relative suffers anaphylactic shock from peanuts, itchiness from poppy seeds is immaterial. Finally, limiting feedback to the high-severity allergens allowed for a more succinct summary of the participant's performance.

Results

Overall Recall Performance

Analyses were conducted to examine age-related differences in recall, irrespective of item value. The proportion of allergens recalled as a function of participant age group and list are

provided in Table 1. A 2(Age group: younger adults, older adults) x 3(List: 1, 2, 3) repeated-measures ANOVA on total recall revealed a significant Age group x List interaction, $F(2, 92) = 5.93$, MSE = .01, $p = .004$, $\eta^2_G = .04$. This interaction reflected age group differences in List 1 recall, in which older adults' recall was significantly lower than younger adults' recall, $t(46) = -4.25$, $d = -1.26$, $p < .001$. Interestingly, there were no significant differences between younger and older adults' total recall in either List 2 or List 3. Additionally, while older adults' total recall did not significantly change across lists, younger adults recalled significantly more items in List 1 than in either List 2, $t(23) = 3.12$, $d = .64$, $p = .005$, or List 3, $t(23) = 3.16$, $d = .64$, $p = .004$, which may reflect interference effects as more allergens were presented. Although both age groups likely experienced List 1 interference during their study and recall of List 2 allergens, younger adults may have experienced greater proactive effects owing to the fact that they successfully recalled more List 1 allergens than older adults. Thus, younger adults may have initially had more interfering elements with which to contend.

Value-Directed Remembering and Selectivity

Participants likely differ in how they strategically attended to the values and what they considered important to remember. A participant who expects that remembering all of the items would be difficult, for instance, may have exclusively attended to the allergens with a rating of either 9 or 10, while other participants may have considered items with ratings greater than 7 equally worthy of attention during study. Both hypothetical groups would have been engaging in a value-directed remembering strategy, but differences in strategy use and selectivity would not be represented via value-based binning (e.g., "low" value items). Hierarchical linear modeling (HLM) takes into account a variety of within-subject and between-subject differences in value-based recall strategies within the broader study of age-group differences (Raudenbush & Bryk,

2002). Figure 1 depicts the probability of older and younger adults recalling an item as a function of its specific value and list.

In our model (level 1 = items; level 2 = participants), item-level recall performance (based on a Bernoulli distribution, with 0 = *not recalled* and 1 = *recalled*) is modelled as a function of each item's value, its respective list, and the interaction between value and list. Value and List were entered as group-mean centered variables, such that Value was anchored on the mean value point (5.42) and List was anchored on List 2. The interaction was computed as a multiplicative of the centered Value and List terms. The model further incorporated age group as a level-2 predictor of these level-1 effects, with the Age group variable anchored on older adults (i.e., 0 = *older adults*, 1 = *younger adults*). Table 2 reports the tested model and its estimated regression coefficients (Murayama, Sakaki, Yan, & Smith, 2014). As the model is essentially a logistic regression model with a dichotomous dependent variable, the regression coefficients can be interpreted via their exponential. Specifically, exponential beta, Exp(B), is interpreted as the effect of the independent variable on the odds ratio of successful memory recall (i.e., the probability of recalling items divided by the probability of forgetting them).

Value was a significantly positive predictor of recall performance ($\beta_{10} = 0.17$, $p < .001$; note that this coefficient represents the effect for older adults as the age group variable was anchored on older adults), and this relationship was not moderated by Age group ($\beta_{11} = 0.02$), indicating that there was no evidence of a significant difference in this value-recall relationship between younger and older adults. Thus, severe (high-value) allergens were generally better recalled than were milder allergens by both younger and older adults; participants were exp(0.17) = 1.19 times more likely to recall an allergen for each one-unit increase in its severity. While there were no significant differences in recall as a function of List ($\beta_{20} = 0.08$), there was a

significant cross-level interaction between List and Age group, such that the differences in overall recall between younger and older adults decreased with progressive lists (β_{21} = -0.31, $p <$ .001).

Results also indicated an interaction between List and Value, such that the relationship between item value (i.e., allergen severity) and recall probability increased with each successive list (β_{30} = 0.10, $p <$ .001). In other words, as the experiment progressed and participants became more familiar with the design and its demands, participants became more selective, with recall increasingly contingent upon allergen severity. Interestingly, there was no evidence of significant age-related differences in this pattern of value-directed remembering (β_{31} = -0.04), such that younger and older adults exhibited the same degree of increasing attention to value with task experience.

Memory for severe allergens

Table 1 presents younger and older adults' average recall as a function of list and value bin. A 2(Age group) x 3(List) repeated-measures ANOVA was conducted on high-value item recall (i.e., items rated 8-10), as depicted in Figure 2, to determine whether prior results (see Castel, 2008 and Castel et al., 2012) were upheld in the current experiment. Having found a significant Age group x List interaction, $F(2, 92) = 4.44$, MSE = .053, $p = .01$, $\eta^2_G = .05$, follow-up analyses indicated specific age-related differences in List 1, with younger adults recalling significantly more high-value items than older adults, $t(46) = 3.72$, $d = 1.10$, $p = .001$ (see Table 1). No age-related differences were present on List 2 or List 3, p's > .60. Notably, younger adults' high-value recall did not significantly differ across lists, but older adults' high-value item recall significantly increased with task experience, with high-value recall significantly greater in List 3 than in List 1, $t(23) = 4.00$, $d = 0.82$, $p = .001$.

Selectivity index

The selectivity index (Castel et al., 2002; Watkins & Bloom, 1999) is a measure of the extent to which the items recalled by participants are maximally valuable, of how much one's recall score (a sum of the recalled items' associated values) differs from the ideal (see Castel et al., 2002 and Watkins & Bloom, 1999 for more information regarding the selectivity index). A 2(Age group) x 3(List) repeated-measures ANOVA revealed a main effect of List, $F(2, 92) = 10.66$, MSE $= .098$, $p < .001$, $\eta^2_G = .09$. Follow-up analyses indicated that the average selectivity index across participants in List 1 ($M = .16$, $SD = .39$) was significantly less than in List 2 ($M = .36$, $SD = .41$), $t(47) = -3.07$, $d = -0.44$, $p = .004$, and List 3 ($M = .44$, $SD = .35$), $t(47) = -4.40$, $d = -0.64$, $p < .001$. The selectivity indices of Lists 2 and 3 did not significantly differ. There was evidence of neither significant Age group differences nor of an interaction between Age group and List. These results are consistent with the aforementioned hierarchical modeling analyses.

Discussion

Despite age-related differences in total recall, younger and older adult participants were both sensitive to allergen severity, remembering those allergens that would have caused their (fictional) young relative the most suffering had they been forgotten. Notably, age-related differences in value-based recall were reduced with task experience. In fact, while younger adults' high-value recall did not significantly change across lists, older adults' recall of the highly consequential allergens increased. Participants also became increasingly more selective and, interestingly, this selectivity did not appear to differ between younger and older adults.

The improvement in high-value recall suggests that older adults were able to reassess and update their encoding strategies, consistent with the notion of predominantly intact metacognitive processes despite age-related impairments in recollection (Hertzog & Dunlosky,

2011; McGillivray & Castel, 2011). Younger adults' selectivity did improve with task experience, but this improvement appeared to result from a prioritization of medium-value items over low-value items, rather than an increase in high-value recall, as preferential attention to high-value items at the expense of low- and medium-value items was already apparent in List 1.

In the present experiments, the task instructions strongly emphasized attending to the high-value allergens, which may partly explain why participants exhibited an immediate value-directed remembering pattern for List 1. Prior experiments have, however, demonstrated value-directed remembering without explicitly referring to item value as it related to recall goals (Friedman et al., 2015) or to high-value items specifically (Castel, Lee, Humphreys, & Moore, 2011; Castel, Murayama, Friedman, McGillivray, & Link, 2013). Making the instructions less explicit might impact List 1 performance, in that participants could otherwise overestimate their ability to remember all of the items and thus not immediately take item value into account, but it is not thought that the instructions alone account for the overall performance or selectivity improvements. The potential for severe health-related consequences for not recalling certain items may have affected how people determined the need to remember high-value items.

Experiment 1 adopted a "health risk prevention" framework: remembering the allergens maintained the young relative's health, but a failure to recall a given allergen led to an unhealthy reaction of ranging severity. Despite the attention to value, particularly by List 3, none of the participants demonstrated perfect performance, and few older adults demonstrated perfect high-value recall at any point, so all of the participants' young relatives experienced an allergic reaction of some degree. The overarching tone of the task was thus rather negative (health impairments, risk to life, etc.). This general negativity may conflict with older adults' inclination towards positive information in their pursuit of emotion regulation (Carstensen, Isaacowitz, &

Charles, 1999; Lang & Carstensen, 2002). Older adults' greater attention to emotionally and socially relevant information could differentially affect their recall performance and selectivity.

Experiment 1 may be emotionally salient, but there remains the possibility that a more positive lean to the task could further encourage selectivity in older adults. A positive framework would coincide with emotion regulation goals while continuing to provide the benefit of contextual/conceptual support. Furthermore, older adults have been shown to focus more on gains than losses (Samanez-Larkin et al., 2007). In Experiment 1, the goal was to avoid negative consequences, but successful loss avoidance only maintained the status quo. How might selectivity be impacted by a more proactive approach to improving the young relative's health?

Experiment 2

In Experiment 2, the goal shifts from a health risk prevention frame (avoiding negative consequences) to that of health promotion (positive consequences) in which presented food items vary in the degree to which they improve a fictional young relative's immune system. There are many articles concerning the benefits of eating certain foods; recent publications in AARP Magazine (Jaret, 2014; Simon, 2013) suggest that attention to nutrition and proactively managing one's health is a central focus to younger and older adults alike.

Emotion regulation literature suggests that older adults' attention may tend towards the most positively consequential items, furthering selectivity efforts. On the other hand, though there was nothing specific to gain by remembering items in Experiment 1, there is nothing specific to lose by forgetting Experiment 2 items. A lack of negative consequences could dampen inclination towards selectivity; there may be insufficient motivation to modify study strategies in any effortful way to achieve maximal selectivity when remembering *any* health foods will lead to some gain. Furthermore, the overarching negativity of the consequences in

Experiment 1 may have discouraged item-by-item attendance; the less severe/consequential allergens may have been less distracting because older adults were generally less inclined to attend to negative items in the first place. Positive items of low consequence could be more distracting, owing to older adults' positivity bias (Mather & Carstensen, 2005), than negative items of similarly severe consequence.

Methods

Participants

Participants consisted of 24 younger adults (20 female) and 24 older adults (16 female). Younger adult participants were undergraduate students at the University of California, Los Angeles, ranging in age from 18 to 25 years ($M = 19.71$, $SD = 1.77$). Older adult age ranged from 64 to 89 years ($M = 77.67$, $SD = 8.01$), with years of education ranging from 12 (2 high school graduates) to 16+ (10 graduate degrees). Recruitment and compensation was the same as described in Experiment 1.

Materials

Stimuli consisted of 36 common foods (e.g., yogurt, banana, coffee), including the 21 food allergens from Experiment 1. Items were selected based on ratings from pilot participants with respect to their perceived healthiness ("How healthy are these foods?") on a 5-point Likert scale from "Not healthy at all" to "Extremely healthy." Items with an average rating of less than 2.33 were designated to be of low health, between 2.34 and 3.67 of medium health, and greater than 3.68 of high health. The chosen items were distributed across three lists so each list was equivalent in terms of average health rating per item and consisted of 4 items each of low, medium, and high health, as per the pilot ratings. Each list contained roughly the same number of items within a given food category (e.g., one type of nut). Items averaged 7.58 ($SD = 1.34$) on

the log-transformed HAL frequency scale and ranged from 4.79 to 9.82. The foods were counterbalanced across 3 conditions (A, B, and C) with respect to how beneficial they were. Values were divided into three bins consisting of four foods apiece: low benefit (0-3), medium benefit (4-7), and high benefit (8-10). Across the 3 conditions, each of the 36 foods featured in each value bin so as to account for any individual differences between participants regarding the plausibility of a particular item-value pairing. List presentation order was also counterbalanced across the conditions. The study was designed and presented to participants via the Collector program (Gikeymarcia/Collector, n.d.)

Procedure

Participants were to imagine that a young relative had recently undergone her annual checkup, during which her doctor had compiled a list of foods, specifically based on her exam results, which she should consume to boost her immune system. As this relative would soon be visiting, it was important for the participant to remember the most beneficial foods in order to improve her health and wellbeing.

The general design for Experiment 2 was nearly identical to that of Experiment 1. Item values ranged from 0 to 10 to express how beneficial each food would be to the relative, with 0 indicating that the relative would not experience any particular boost to her immune system by consuming the food and 10 that the food was very beneficial (she should definitely eat it!). As in Experiment 1, participants received feedback pertaining to their recall of the highly beneficial foods (e.g., "You left out cranberries, which was worth 10 points. Remember, foods with ratings of 8, 9, or 10 are very good for your relative's health and immune system. It's important that she eat these foods while you're hosting her!").

Results

Overall Recall Performance

The proportion of beneficial foods recalled as a function of participant age group and list are provided in Table 1. A 2(Age group) x 3(List: 1, 2, 3) repeated-measures ANOVA on total recall revealed a significant main effect of Age group, with older adults recalling fewer items overall than younger adults, $F(1, 46) = 9.30$, MSE $= 0.04$, $p = .004$, $\eta^2_G = .12$. There was a main effect of List, $F(2, 92) = 12.83$, MSE $= .01$, $p < .001$, $\eta^2_G = .07$: significantly more items were recalled in List 1 than List 2, $d = 0.53$, or List 3 ($M = 0.42$, $SD = 0.14$), $d = 0.64$, p's $< .002$. Recall rates did not differ between Lists 2 and 3. There was no interaction between Age group and List.

Value-Directed Remembering and Selectivity

In order to examine how participants strategically incorporated item value during study to yield maximally selective recall, we applied the same HLM analysis to the data as was done in Experiment1 (see Table 2). Figure 3 depicts the probability of recalling an item as a function of its specific value. Consistent with Experiment 1, Value was a significantly positive predictor of recall performance ($\beta_{10} = 0.28$, $p < .001$), and there was no significant difference in this value-recall relationship between younger and older adults ($\beta_{11} = -0.004$). Highly beneficial foods were generally better recalled than less beneficial foods; participants were $\exp(0.28) = 1.32$ times more likely to recall a food for each one-unit increase in the degree to which the relative would benefit from its consumption. Additionally, there was a significantly negative relationship between list progression and recall probability ($\beta_{20} = -0.36$, $p < .001$), with no significant age-related differences ($\beta_{21} = 0.08$). The decline in recall exhibited by all participants after List 1 appears to predominantly stem from reduced recall of foods with little benefit (see Figure 3) and may reflect interference from prior lists. There was a significant interaction between List and

Value, such that the relationship between the benefit of a given food and its probability of being recalled increased with each successive list ($\beta_{30} = 0.11$, $p < .001$). Once again, age-related differences in this pattern were not significant ($\beta_{31} = -0.01$). Younger and older adults became similarly more selective with task experience – recall was increasingly contingent upon the degree of benefit experienced by the relative.

Memory for highly beneficial foods

A 2(Age group) x 3(List) repeated-measures ANOVA was conducted on recall of high-value food items. High-value recall differed as a function of Age group, $F(1, 46) = 11.16$, MSE = 0.101, $p = .002$, $\eta^2_G = .11$, with younger adults recalling significantly more high-value items than older adults (see Table 1). There were no significant effects List, nor was there an Age group x List interaction.

Selectivity index

A 2(Age group) x 3(List) repeated-measures ANOVA on the selectivity indices revealed a main effect of List, $F(2, 92) = 7.89$, MSE = .090, $p = .001$, $\eta^2_G = .06$. Selectivity across participants in List 1 ($M = 0.31$, $SD = 0.39$) was significantly less than in List 2 ($M = 0.48$, $SD = 0.38$), $t(47) = -2.86$, $d = -0.41$, $p = .006$, and List 3 ($M = 0.55$, $SD = 0.42$), $t(47) = -3.720$, $d = -0.54$, $p = .001$. The selectivity indices of List 2 and List 3 did not significantly differ. Calculated selectivity also did not significantly differ by Age group, nor was there a significant Age group x List interaction. These results are consistent with the hierarchical linear modeling analyses: with task experience, both younger and older adults exhibited a similar boost in selectivity.

Discussion

Under the health promotion framework of Experiment 2, younger and older adults were equally sensitive to value, demonstrating the greatest memory for foods associated with the most

positive health consequences and an increase in selectivity across lists. While preferential attention towards high-value foods was apparent even in List 1, there were no significant changes across lists. Thus, contrary to prior work, age-related recall differences were not attenuated for the most important items (Castel, 2008; Castel et al., 2012). The increase in selectivity also appears to have been driven by a decrease in the recall of less beneficial foods, rather than a shift towards high-value items specifically. While participants did promptly attend to value, doing so may have dissuaded metacognitive reassessments and changes in study strategy that might have improved high-value recall, as is further considered in the General Discussion.

General Discussion

People regularly need to remember important health-related information, whether from a preventative or reactive standpoint. The current experiments expand upon prior value-directed remembering research to investigate how selectivity efforts fare with respect to consequential health information and whether younger and older adults' selectivity is differentially impacted by the nature of the consequence. Younger and older adult participants successfully engaged in value-directed remembering in both Experiments 1 and 2, attending to the most important items within each context (the most severe allergens and the most beneficial foods, respectively) and becoming increasingly selective with task experience. These experiments indicate that both younger and older adults are similarly capable of engaging in value-directed remembering when the item value stems from negative and positive health-related information.

The two experiments provide some converging evidence as to how younger and older adults can remember important health-related information, as well as how this might be influenced by the consequences of the information in question. Calculated selectivity

performance suggests that older adults initially responded more to the positive consequences in Experiment 2 than to the negative consequences in Experiment 1. In terms of high-value recall, however, older adults showed the greatest improvement in Experiment 1, recalling increasingly more severe allergens across lists, than in Experiment 2, during which recollection of highly beneficial foods remained constant.

Adopting a value-based encoding strategy is considered to be a consequence of metacognitive assessments of one's expected performance ability. It may be that the necessity of attending to the high-value items in order to be successfully selective leads to an imbalanced trade-off in subsequent lists (i.e., after List 1) such that people cannot recall the lower-valued items. Additionally, older adult participants in Experiment 2 may have judged their initial value-based performance to be "good enough," making any changes to strategy seem unlikely to lead to improvements warranting expended effort. In Experiment 1, older adults generally failed to recall at least 2 of the 4 high-value allergens. The potential for improvement in Experiment 2 may have been somewhat less obvious as older adult participants typically recalled at least 3 of the high-value foods. In a post-hoc analysis, the 10 older adults in Experiment 2 who initially recalled 2 or fewer of the severe allergens *did* show significant improvements in their recall by the final list, suggesting that "low" performers in Experiment 2 may indeed have shifted their strategies.

The lack of serious consequences for failing to remember items in Experiment 2 may also explain the absence of improvement in high-value recall and the endurance of age-based recall differences; remembering *any* of the items led to health improvements. Perhaps the positive nature of the stimuli/context in Experiment 2 prompted the initial attention to value and selectivity, but the serious consequences for forgetting in Experiment 1 prompted the quick

improvements. If this is the case, combining these elements might lead to automatic attention to value *and* an elimination of age-based recall differences for the most important items. For instance, participants might be told that their young relative is sick, but the foods they are to remember will help to make her better. Thus, there would still be positive consequences for remembering the items (her health improves), but implied negative consequences for forgetting (her health does *not* improve).

There appeared an attenuated need for task experience relative to prior value-directed remembering research (Castel et al., 2002; McGillivray & Castel, 2011): age-related differences in high-value recall during Experiment 1 were already eliminated by List 2, and there was a consistent absence of significant age-related differences in selectivity in both Experiments 1 and 2. This may have resulted from the schematic support afforded by the tasks' conceptual and health-related nature. Although apparently helpful in the current experiments, older adults' reliance on schematic support (Umanath & Marsh, 2014) might prevent them from properly attending to health information that is inconsistent with held beliefs (Rice & Okun, 1994; Friedman & Castel, 2013).

It should be noted that the improvement across lists in the current experiments and prior research (Castel, 2008) may be a consequence of post-recall feedback, increased familiarity with the task, or a combination of these factors. Given the present design, it would be impossible to tease apart the contribution of these two elements since all participants received feedback after each list's recall period. It seems relatively improbable, however, that participants would modify their selectivity during study without having received some indication of their prior performance. In order for feedback to be unnecessary, participants would need to be consistently aware of any failure to recall one or more of the high-value items. While some participants may be cognizant

of their omission, feedback ensures that high-value neglect is explicitly brought to the attention of participants who are either oblivious to the omissions or mistakenly believe that they *did* successfully recall the high-value items. Prone to associative binding deficits (see Old & Naveh-Benjamin, 2008 for a review) and source memory errors (Chalfonte & Johnson, 1996), feedback may be particularly important for older adults, as they may be more likely to miscombine items and values during study and later mistakenly believe that they had recalled the high-value items. The decision to shift to a more selective study strategy is likely aided by task familiarity, but is almost certainly dependent upon an accurate depiction of one's prior performance, guaranteed only through feedback.

Summary   Memory fallibility can be perturbing. When it comes to important health-related information, though, memory errors can be quite serious and efforts must be made in understanding how they might be avoided, particularly with advancing age. The results of the present research indicate that younger and older adults demonstrate value-directed remembering and selective study when presented with conceptual information framed within a context of consequence severity. With task experience, participants seemed to respond more successfully to the health information associated with negative consequences. The results from the present research suggest that both younger and older adults may require a certain amount of task experience and/or awareness of their memory limitations in order to successfully remember vital health-related information.

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Table 1

Recall probability in Experiment 1 and Experiment 2 as a function of List, Value bin, and Age group

		Value bin	List 1	List 2	List 3
Experiment 1	Younger adults	High	0.76 (0.24)	0.64 (0.29)	0.72 (0.24)
		Medium	0.54 (0.30)	0.57 (0.25)	0.45 (0.16)
		Low	0.55 (0.24)	0.30 (0.29)	0.36 (0.30)
	Older adults	High	0.51 (0.24)	0.60 (0.25)	0.73 (0.24)
		Medium	0.38 (0.24)	0.45 (0.31)	0.40 (0.24)
		Low	0.44 (0.30)	0.30 (0.23)	0.31 (0.27)
Experiment 2	Younger adults	High	0.80 (0.26)	0.74 (0.23)	0.80 (0.19)
		Medium	0.46 (0.28)	0.42 (0.27)	0.36 (0.34)
		Low	0.43 (0.24)	0.34 (0.33)	0.24 (0.26)
	Older adults	High	0.60 (0.30)	0.58 (0.23)	0.61 (0.29)
		Medium	0.46 (0.22)	0.36 (0.26)	0.33 (0.25)
		Low	0.35 (0.29)	0.17 (0.18)	0.16 (0.24)

Note. Standard deviations are presented in parentheticals. "Low" refers to items rated 0-3, "Medium" to items rated 4-7, and "High" to items rated 8-10. Within each list, there were 4 items per value bin.

Table 2

Two-level hierarchical generalized linear model of recall performance predicted by item value, list, and participant age

Fixed effects	Coefficient: Experiment 1	Coefficient: Experiment 2
Intercept (β_{00})	-0.20	-0.58***
Predictors of intercept		
Age (person-level) (β_{01})	0.41*	0.54**
Value (β_{10})	0.17***	0.28***
Predictors of value		
Age (β_{11})	0.02	-0.001
List (β_{20})	0.08	-0.36***
Predictors of list		
Age (β_{21})	-0.31***	0.08
List x Value (β_{30})	0.10***	0.11***
Predictors of List x Value		
Age (β_{31})	-0.04	-0.02
Random effects	**Variance**	**Variance**
Intercept (person-level) (r_0)	0.16***	0.31***
Value (r_1)	0.02***	0.04***

Note. The dependent variable is recall performance coded as 0 (*not recalled*) or 1 (*recalled*). Logit link function was used to address the binary dependent variable. Level 1 models were of the form $\eta_{ij} = \pi_{0j} + \pi_{1j}$ (Value) $+ \pi_{2j}$ (List) $+ \pi_{3j}$ (List x Value). Level 2 models were of the form $\pi_{0j} = \beta_{00} + \beta_{01}$ (Age) $+ r_{0j}$, $\pi_{1j} = \beta_{10} + \beta_{11}$ (Age) $+ r_{1j}$, $\pi_{2j} = \beta_{20} + \beta_{21}$ (Age), $\pi_{3j} = \beta_{30} + \beta_{31}$ (Age). *p < .05 **p < .01 ***p < .001
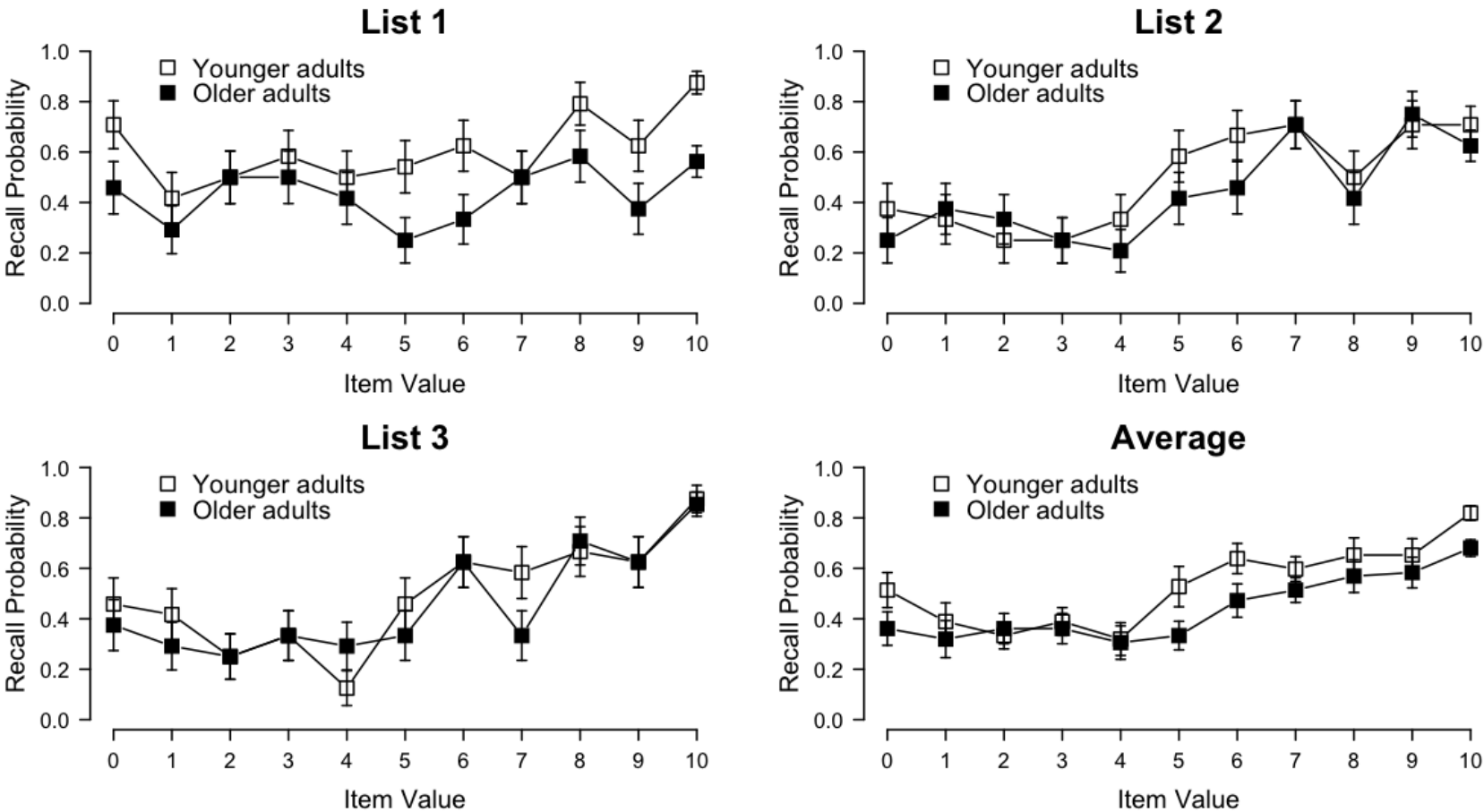
Figure 1. Recall probability as a function of item value (i.e., allergy severity) in Experiment 1 as a function of List and Age group.
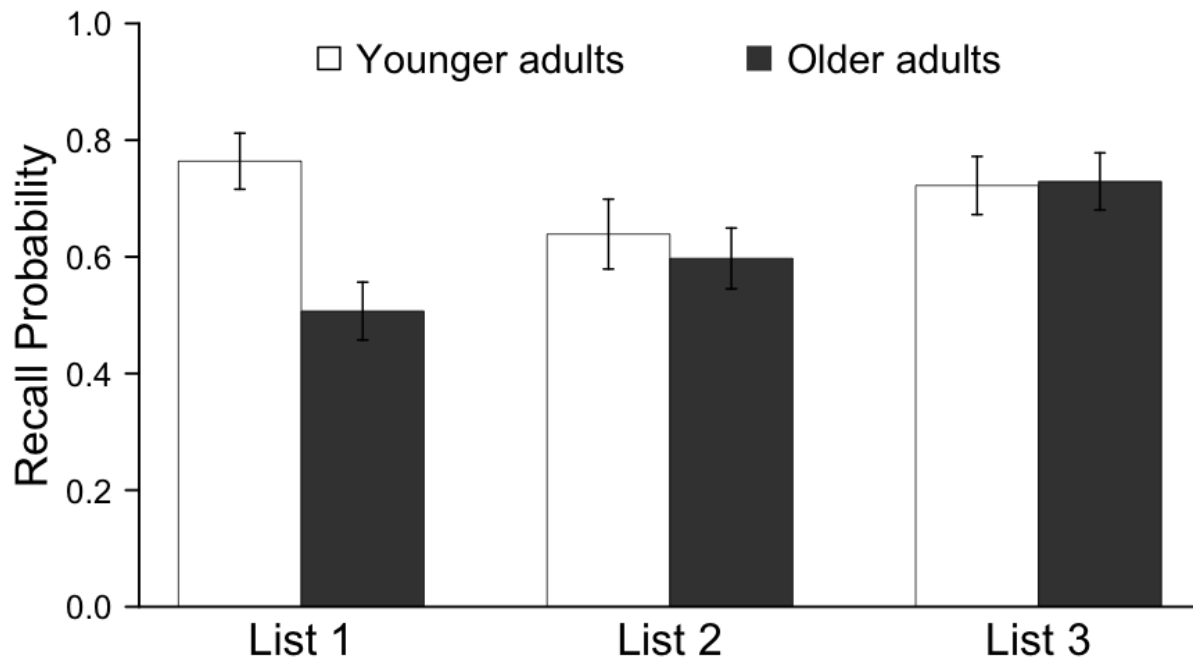
Error bars reflect standard error.

Figure 2. Recall probability of high-value items (i.e., severe allergens) in Experiment 1 as a function of List and Age group. Error bars reflect standard error.
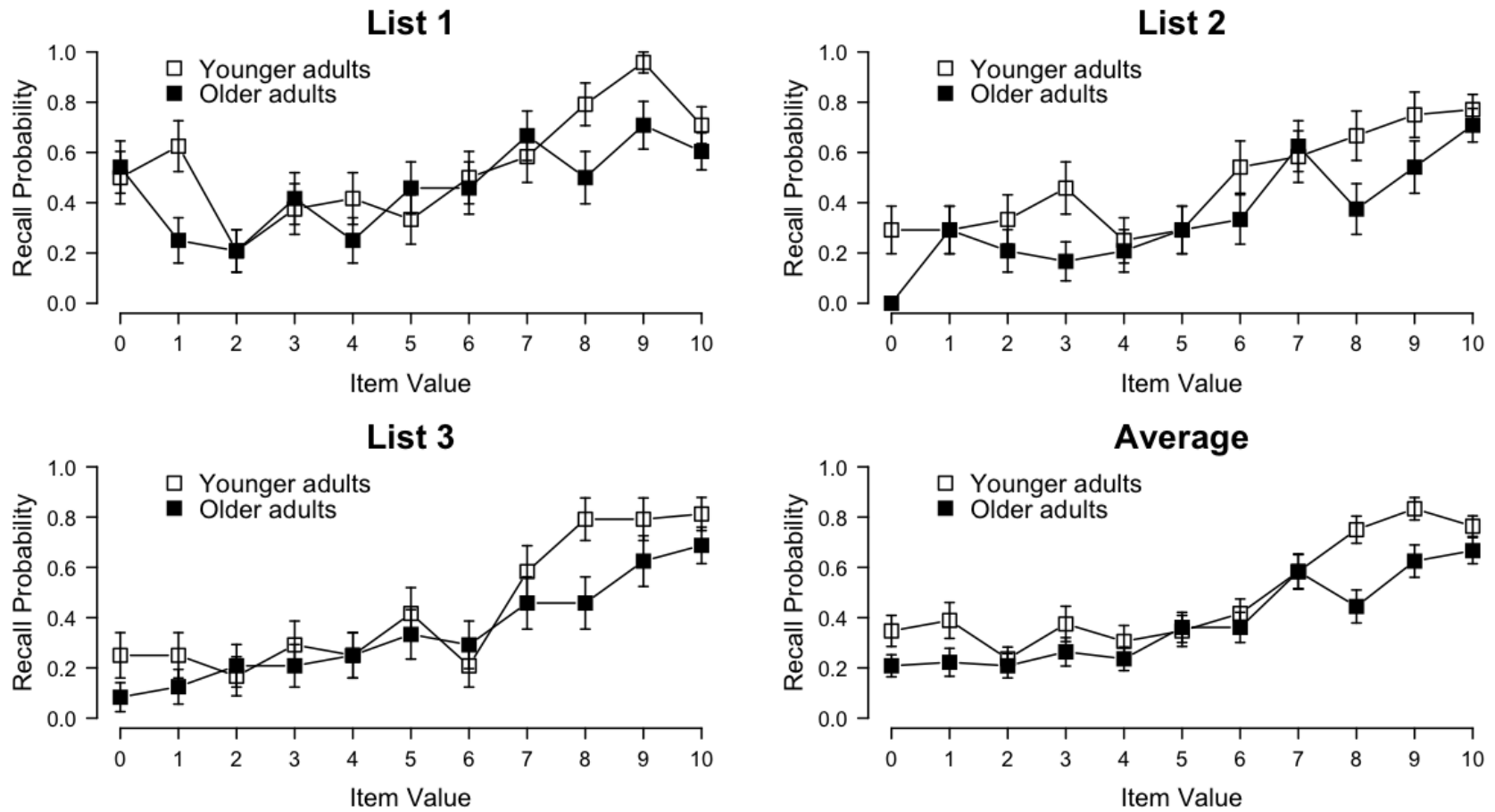
Figure 3. Recall probability as a function of item value (i.e., health benefit) in Experiment 2 as a function of List and Age group. Error bars reflect standard error.