

Age and Self-Relevance Effects on Information Search During Decision Making

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Objectives. We investigated how information search strategies used to support decision making were influenced by self-related implications of the task to the individual. Consistent with the notion of selective engagement, we hypothesized that increased self-relevance would result in more adaptive search behaviors and that this effect would be stronger in older adults than in younger adults.

Method. We examined search behaviors in 79 younger and 81 older adults using a process-tracing procedure with 2 different decision tasks. The impact of motivation (i.e., self-related task implications) was examined by manipulating social accountability and the age-related relevance of the task.

Results. Although age differences in search strategies were not great, older adults were more likely than younger adults to use simpler strategies in contexts with minimal self-implications. Contrary to expectations, young and old alike were more likely to use noncompensatory than compensatory strategies, even when engaged in systematic search, with education being the most important determinant of search behavior.

Discussion. The results support the notion that older adults are adaptive decision makers and that factors other than age may be more important determinants of performance in situations where knowledge can be used to support performance.

Key Words: Aging—Decision making—Motivation—Process tracing—Strategy.

THE ability to make effective decisions is an important aspect of everyday functioning, arguably increasing in significance in later life as personal resources become more limited and older adults strive to maintain independence. Recent research suggests that the impact of aging on decision making is multifaceted (e.g., Bruine de Bruin, Parker, & Fischhoff, 2007). For example, in situations where knowledge is of little benefit, working memory or executive skills are important determinants of performance, and normative declines in these abilities may prove problematic for older adults (Henninger, Madden, & Huettel, 2010). However, preserved functioning of affective systems in later adulthood may partially compensate for the negative impact of cognitive ability (Mikels et al., 2010; Peters, Hess, Auman, & Västfjäll, 2007). Similarly, adaptive functions, such as knowledge based in past experience, might facilitate performance by identifying analogies with past scenarios and highlighting distinctions between relevant and irrelevant information. Both may result in the development of heuristics that reduce strain on cognitive resources while maintaining high levels of effectiveness. Knowledge-based processes may compensate for reductions in cognitive resources in later life and may even result in improved performance if relevant experience is tied to age.

Adaptive functioning might also be reflected in decision making through linkages with age-related motivational factors associated with changing life contexts. For example,

increases in the focus on affective outcomes and aversion to risk have been shown to impact decision making in later life (Löckenhoff & Carstensen, 2007). Adaptive motivational processes may also be evident in task engagement, which is influenced by age-related changes in cognitive resources with age. Hess and colleagues (Hess & Emery, 2012; Hess & Queen, in press) have argued that aging is associated with an increase in the costs (e.g., effort, fatigue) associated with cognitive performance (Ennis, Hess, & Smith, in press; Hess & Ennis, 2012) and that these increased costs negatively affect older adults' willingness to engage cognitive resources (Hess, Emery, & Neupert, 2012). This results in heightened selectivity in the allocation of resources in support of performance in later life, with the personal relevance of the task becoming increasingly important with age. This age-based selective engagement leads to the expectation that age differences in decision making will be greatest under conditions with minimal implications for self. Several studies examining judgment processes have supported this perspective (e.g., Hess, Germain, Rosenberg, Leclerc, & Hodges, 2005; Hess, Leclerc, Swaim, & Weatherbee, 2009).

Our goal was to examine the impact of these adaptive motivational functions on the decision-making process. We specifically focused upon individuals' decision search strategies. Using a process-tracing procedure, participants searched large information matrices, which allowed us to assess the amount of information sampled and the

patterns of sampling. The matrix format has the advantage of being similar to real-life decision contexts (e.g., comparisons of health plans) and has been used in past studies examining the impact of aging (Johnson, 1990, 1993; Johnson, & Drungle, 2000; Queen, Hess, Ennis, Dowd, & Grünh, in press; Riggle & Johnson, 1996) and motivation (Lee, Herr, Kardes, & Kim, 1999; Sen & Johnson, 1997; Verplanken & Holland, 2002). Previous research suggests that relative to younger adults, older adults examine fewer pieces of information (Schaninger & Sciglimpagalia, 1981) and use satisficing strategies (Johnson, 1990), reflecting a limited information search focused on identifying acceptable rather than optimal choices. Age differences in search strategies may also be moderated by factors such as familiarity (Johnson & Drungle, 2000) and goals (Löckenhoff & Carstensen, 2007). For example, Johnson and Drungle found that older adults' greater experience in purchasing over-the-counter drugs resulted in more organized search than less-experienced younger adults. Unfortunately, there has been little systematic examination of factors related to adaptive functioning within the same study, making generalizations regarding the moderating impact of knowledge and motivation difficult.

We addressed this concern by explicitly contrasting performance across two sets of conditions designed to affect self-related implications of the decision task, which we assume affect the motivation to engage in the task. First, we manipulated the age-relevant content, which we hypothesized would determine age differences in search behaviors. We expected engagement to be higher and search to be more systematic when the task content was more relevant to the participant's age group. Consistent with research examining selective engagement (Germain & Hess, 2007; Hess et al., 2005; Hess, Rosenberg, & Waters, 2001), we further predicted that personal relevance would have a stronger impact on the search behavior of older relative to younger adults.

Second, we manipulated the extent to which participants were held accountable for their performance. Participants in the high-accountability condition were informed that they would have to justify their decisions to the tester; in contrast, those in the low-accountability condition simply made a decision without explanation. Accountability has been demonstrated to increase task engagement (for review, see Lerner & Tetlock, 1999) and is assumed to do so by making self-presentation concerns salient. We predicted that individuals would be more engaged and systematic in information search when held accountable for their decisions (Lee et al., 1999; Vieider, 2009). Consistent with other aging research and the selective engagement hypothesis (Chen, 2004; Hess, Germain, Swaim, & Osowski, 2009; Hess et al., 2001), the impact of accountability was also expected to be stronger in the older group than in the younger group.

An important question concerns the nature of the impact of these motivational factors. If heightened implications for self lead to increased engagement in the task, how would

this be reflected in search behavior? One hypothesis is that low engagement is associated with sampling fewer pieces of information, comparing alternatives on a relatively small subset of attributes, and spending less time studying information. This might be related to the use of relatively simple noncompensatory strategies, such as satisficing, where sufficient information is sampled in order to make a satisfactory (e.g., "good enough") but not necessarily optimal choice. Such outcomes may be reasonable in situations involving low personal investment. In contrast, greater investment and engagement might lead the decision maker to utilize a compensatory strategy, in which negative attributes associated with an alternative may be compensated for by positive attributes on other decision dimensions (e.g., Payne, Bettman, & Johnson, 1993). An alternative perspective, partially based in views regarding adaptive decision making (Gigerenzer, 2008), is that engagement results in heuristic-based strategies that efficiently guide the search to an optimal decision. Lee and colleagues (1999) found that high accountability was not only associated with a greater focus on sampling different alternatives but also with an increased relative focus on attribute sampling over time. This suggests a mix of compensatory and noncompensatory processes. Thus, engaged participants might be less likely to employ simple satisficing strategies, but they also might not necessarily engage in the classic type of systematic search associated with compensatory strategies. Instead, they may display characteristics associated with both, using strategies that extensively sample information but that are guided by preferences.

Previously, Queen and colleagues (in press) found that individuals of all ages were less likely to use compensatory than noncompensatory strategies, particularly in complex tasks, and that education and ability were positively associated with use of noncompensatory strategies. Noncompensatory strategy use in complex tasks might actually be viewed as more systematic processing as participants utilize less extensive but more focused search. From this perspective, high levels of motivation might be reflected in engagement in systematic noncompensatory strategies. We also examined the participant characteristics tied to strategy use to determine the relative impact of age versus other ability and personal attributes on strategy use. Of interest was whether we could replicate our previous findings regarding the positive association between ability and education and use of noncompensatory strategies.

METHOD

Design

We used a $2 \times 2 \times 2$ (age group \times accountability \times task) mixed factorial design in which younger and older adults were randomly assigned to high- or low-accountability conditions, with approximately half of the participants in each age group assigned to each condition. Participants completed

two different decision tasks—selecting a prescription drug plan (PDP) and wireless phone plan (WPP)—with presentation order counterbalanced across age and accountability.

Participants

Young ($N = 79$, aged 21–41 years, 59% women) and older ($N = 81$, aged 64–90, 50% women) adults were recruited from a participant database of community-dwelling adults (see Table 1 for sample characteristics). Participants received an honorarium of \$30.

Materials

Decision tasks were presented in two information matrices using a process-tracing interface (Mouselab; Willemsen & Johnson, 2011). Both matrices included eight choice options (columns) described by six attribute dimensions (rows). This represented a complex array (48 cells) that our previous research (Queen et al., in press) suggested is likely to result in variability in strategy use across participants. Choices were constructed using WPP for smart phones and PDP based on the dominant characteristics of those available on the market. We assumed that WPPs would be more familiar and relevant to younger than to older adults, whereas the opposite would be true for PDPs. Attribute dimensions for the WPP included monthly cost, number of minutes, messaging availability, data allowance, overage fees, and geographical coverage. Those for the PDP included premium, deductible, copay, coverage-gap availability, pharmacy convenience, and formulary breadth. Cells within matrices contained values describing the choices on each of these dimensions. For example, clicking on the box for the copay attribute for Plan A in the PDP condition revealed a specific monetary value. Alternatives were presented in eight different orders to control for effects associated with choice position. We also developed a handout describing each attribute dimension for both tasks to eliminate the possibility that choice attributes were completely unfamiliar to participants.

Table 1. Participant Characteristics

Measures	Younger adults		Older adults	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age (years)*	32.3	5.4	73.7	6.7
Education (years)*	15.7	2.1	16.6	2.8
SF36 physical health*	50.8	6.3	42.4	8.7
SF36 mental health*	45.7	11.0	56.2	8.2
WAIS III vocabulary	49.4	10.9	51.5	8.2
WAIS III digit-symbol substitution*	82.4	16.3	61.8	14.1
WAIS III letter-number sequencing*	12.0	3.3	9.5	2.5
Need for cognition	4.1	0.8	4.2	0.8
Personal need for structure	3.9	0.9	3.7	0.9

Note. WAIS III = Wechsler Adult Intelligence Scale-III.

* $p < .02$ (comparison between age groups).

Intrinsic motivation was measured using the Personal Need for Structure (PNS; Neuberg & Newsom, 1993) and the Need for Cognition (NFC; Cacioppo, Petty, & Kao, 1984) scales. Participants completed a demographic questionnaire and the SF-36 health survey (Ware, 1993). Subtests from the Wechsler Adult Intelligence Scale-III (WAIS-III; Wechsler, 1997) were used to assess working memory (Letter–Number Series), processing speed (Digit–Symbol Substitution), and verbal ability (Vocabulary).

Participants rated their interest, relevance, familiarity, knowledge, understanding, and competence for both task contexts on a 0–4 scale. They also rated the importance they placed on each of the attribute dimensions, and whether they had experience selecting a plan for themselves or assisting someone else.

Procedure

Participants completed the demographic, health, and motivation questionnaires prior to coming to the lab. Prior to the first task, participants were given practice searching a 4×4 matrix in order to familiarize them with using the computer mouse to search. Mouselab was programmed so that information within the matrix for each task was concealed, requiring participants to click on the cell to reveal the choice description. Only one cell could be opened at a time. Cells remained unmasked until participants clicked on another cell, in which case, the previous cell was again concealed. Although limiting viewing to one cell at a time makes the task somewhat different than some real-life situations, where all the information might be available at all times, it is not inconsistent with web-based searches, where clicking on a link opens a new page. Importantly, our task format also facilitated examination of search strategies. Once participants were familiar with the task, they were told to imagine that they were in the market for a WPP (or PDP) and that the choices in the matrix were those they were considering purchasing. They were told that there was no one correct answer and they could view as much or as little information as they wished. Those in the high-accountability condition were also told the following:

As an informed consumer, it is important that you make good decisions and can justify the basis for these decisions. Therefore, after you have searched through the information in the array and made your choice, I will also ask you to orally justify the decision you made, including the strategy you used to search through the information and the reasons for choosing the alternative that you did.

Those in the low-accountability condition were not given any additional instructions.

Following familiarization with the attribute dimensions, participants viewed the first information matrix and, after viewing the desired amount of information, selected their preferred choice. Those in the high-accountability condition defended their decision and described their choice

strategy into a digital recorder. They then completed the appropriate domain knowledge and familiarity questionnaire. After a short rest break, the second task proceeded in the same manner, with the exception that those in the low-accountability condition were also asked to explain their decisions and strategies. The ability tasks were administered afterward.

RESULTS

A set of 2×2 (age group \times accountability condition) analyses of variance (ANOVA) conducted on the measures listed in Table 1 revealed age differences generally consistent with normative trends observed elsewhere in the literature. There was unexpected variation across accountability conditions, with PNS being significantly higher, $F(1, 156) = 3.96$, $p = .05$, $\eta_p^2 = .03$, and NFC significantly lower, $F(1, 156) = 5.52$, $p = .02$, $\eta_p^2 = .03$, in the high-accountability condition. Given that these differences in intrinsic motivation are inconsistent with the direction of our motivational manipulation, with the potential of weakening its observed impact, we controlled for both scores in our analyses. We also observed a significant age \times accountability interaction for letter–number sequencing scores, $F(1, 156) = 4.55$, $p = .04$, $\eta_p^2 = .03$, with older adults in the high-accountability condition having higher scores than those in the low-accountability condition, and the opposite trend observed for younger adults. This score was also included as a covariate. Unless otherwise described in the following analyses, these covariates did not impact the outcomes reported.

Manipulation Checks

Ratings of relevance and knowledge were examined as manipulation checks using 2×2 (age group \times task) ANOVAs. First, we examined a composite index of task relevance based on the mean of interest, topic engagement, and relevance ratings (Cronbach's $\alpha = 0.82$ [PDP] and 0.80 [WPP]). A significant age \times task interaction was obtained, $F(1, 158) = 24.01$, $p < .001$, $\eta_p^2 = .13$, with older adults reporting higher relevance scores than younger adults for the PDP task ($M_s = 2.92$ vs. 2.57), and the opposite being true for the WPP task ($M_s = 2.71$ vs. 3.17). A knowledge variable was created based on the mean of familiarity, knowledge, understanding, and competence ratings (Cronbach's $\alpha = 0.90$ [PDP] and 0.93 [WPP]). A significant age \times task interaction was obtained for these scores, $F(1, 158) = 135.02$, $p < .001$, $\eta_p^2 = .36$, with older adults having higher knowledge scores on the PDP than younger adults ($M_s = 2.32$ vs. 1.61), whereas the opposite was true for the WPP task ($M_s = 2.02$ vs. 3.17). We also found that 43% of older adults versus 11% of younger adults reported personal experience either selecting a PDP or assisting someone else, $X^2(1) = 27.33$, $p < .001$, whereas 96% of younger adults versus 85% of older adults reported similar experiences with WPP, $X^2(1) = 5.71$, $p = .02$. In sum, age differences

in ratings of relevance and knowledge across tasks were consistent with expectations. Self-reported experience was consistent with these differences, although the majority of younger and older adults had WPP experience. We also expected experience with PDPs to be higher than observed in our older group, which may reflect the relatively healthy or advantaged status of our sample.

Search Characteristics

We used data obtained from Mouselab to characterize the search of participants using $2 \times 2 \times 2$ (age group \times accountability \times task) analyses of covariance (ANCOVA), with PNS, NFC, and letter–number sequencing scores as covariates. Initial analyses also included presentation order, but this factor did not moderate any of the effects of interest and thus was dropped from the analyses reported subsequently. Of primary interest in these and all subsequent analyses was the extent to which our two motivational manipulations had a disproportionate impact on older relative to younger adults' performance.

Search Engagement.—We examined degree of engagement in search by examining total time spent studying the matrix and the amount of information (i.e., proportion of the 48 cells) sampled (Table 2). With respect to study time (one younger and one older outliers excluded), older adults searched longer than younger adults ($M_s = 239$ s vs. 166 s), $F(1, 151) = 18.14$, $p < .001$, $\eta_p^2 = .11$, and those in the high-accountability condition studied longer than those in the low-accountability condition ($M_s = 225$ s vs. 178 s), $F(1, 151) = 7.64$, $p = .006$, $\eta_p^2 = .05$. The predicted age \times accountability \times task interaction was also significant, $F(1, 151) = 4.25$, $p = .04$, $\eta_p^2 = .03$. Follow-up analyses revealed that the age \times accountability interaction was significant for the WPP task, $F(1, 151) = 5.94$, $p = .02$, $\eta_p^2 = .04$, but not for the PDP task, $F < 1$. In the WPP task, older adults searched longer under high- than under low-accountability conditions ($M_s = 235.4$ s vs. 159.1 s), whereas younger adults exhibited similar search times across accountability conditions ($M_s = 138.4$ s vs. 132.4 s). Thus, consistent with expectations, we found that accountability had a disproportionate impact on older adults' behavior, and age differences were greatest in contexts that are perceived as low in personal relevance to older adults.

With respect to proportion of information sampled, participants viewed more cells in the high-accountability than in the low-accountability condition ($M_s = 0.81$ vs. 0.74), $F(1, 153) = 5.08$, $p = .03$, $\eta_p^2 = .03$. The interaction between age and accountability approached significance, $F(1, 149) = 2.76$, $p = .10$, $\eta_p^2 = .02$, with the difference between high- and low-accountability conditions ($M_s = 0.83$ vs. 0.71) being significant for the old, $F(1, 77) = 7.76$, $p = .007$, $\eta_p^2 = .09$, but not for the young ($M_s = 0.79$ vs. 0.77), $F < 1$.

Table 2. Rating and Search Scores as a Function of Age, Accountability, and Task

	Younger adults				Older adults			
	High accountability		Low accountability		High accountability		Low accountability	
	PDP	WPP	PDP	WPP	PDP	WPP	PDP	WPP
Total study time (s)	221	139	170	132	302	235	259	159
Total cells viewed	96.3	78.9	84.2	76.4	89.1	78.8	79.5	57.8
Proportion of cells sampled	0.84	0.74	0.81	0.73	0.86	0.80	0.76	0.66
ARC attribute	0.41	0.37	0.46	0.42	0.39	0.46	0.48	0.55
ARC alternative	0.32	0.38	0.31	0.32	0.34	0.29	0.32	0.24

Notes. ARC = adjusted ratio of clustering; PDP = prescription drug plan; WPP = wireless phone plan. PDP was considered higher in relevance to older adults, whereas WPP was considered higher in relevance to younger adults.

In sum, both accountability and relevance influenced search intensity, although the effects associated with the former tended to be stronger. The impact of relevance is complicated by the fact that all participants had more experience—although not necessarily more knowledge or perceived relevance—with the young-relevant task (i.e., WPP) than with the old-relevant task (i.e., PDP). Consistent with the selective engagement hypothesis, the impact of the two motivational variables was more consequential for the older than for the younger adults.

Search Organization.—To examine participants' engagement in attribute-based versus alternative-based search, we calculated adjusted ratio of clustering (ARC; Roenker, Thompson, & Brown, 1971) scores based on either repetitions between alternatives on the same attribute dimension or repetitions within the same alternative across attribute dimensions. The former is more characteristic of noncompensatory strategies, whereas the latter is more characteristic of compensatory strategies (Payne et al., 1993). Analyses revealed a significant age \times task \times ARC score interaction, $F(1, 153) = 7.01, p = .009, \eta_p^2 = .04$. Attribute-based search was greater than alternative-based search for both age groups in the low-relevance task, whereas this difference was reduced in the high-relevance task due to an increase in alternative-based and a decrease in attribute-based search (Table 2). This suggests that higher relevance is associated with an increase in compensatory and a decrease in noncompensatory strategy use. Note, however, that attribute-based search ARC scores were higher than alternative-based scores in every condition. There was no differential impact of our two motivational factors across age groups.

Strategy Use

Classification.—The analysis of search characteristics suggested that age, personal relevance, and accountability influenced the manner in which information was searched. To get a better idea of use of specific strategies, we used an algorithm developed by Riedl, Brandstätter, and Roithmayr (2008) that utilizes data from Mouselab (e.g., order and number of cells viewed for each attribute) to identify six different strategies (see also Queen et al., in press). Somewhat

unexpectedly, the vast majority of participants were classified as using a satisficing strategy (89.4% in PDP task, 91.2% in the WPP task). The remainder was classified as using some form of compensatory strategy. Note that the Riedl and colleagues algorithm is focused more on ratios (e.g., ratio of alternative-based to attribute-based comparisons) than on absolute amounts of information sampled, and thus may classify different people as satisficers even if they sample dramatically different amounts of information. In examining the data more closely, we noticed that individuals classified as satisficers varied greatly in terms of the amount of information searched, with some sampling a large percentage of information and others engaging in a more impoverished search. For example, in the PDP task, 50% of participants classified as using satisficing sampled greater than or equal to 90% of the information in the matrix, with the remaining satisficers examining from 13% to 89% of the cells. We reasoned that individuals in the latter group were more akin to “true satisficers,” sampling limited amounts of information to find a “good enough” solution. In contrast, the “elaborate satisficers” were likely engaging in a more systematic search using their preferences to guide them. We re-classified participants who were initially identified as satisficers but who engaged in extensive information sampling—based on median split of cells viewed in each task (90% for PDP, 77% for WPP)—as simply using a noncompensatory strategy. Table 3 presents specific information about search characteristics for each strategy type.

Table 4 presents information about strategy use as a function of age, task, and accountability. Comparisons within tasks revealed no significant age differences, although older adults, relative to younger adults, had somewhat lower rates of compensatory strategy use (4.9% vs. 12.7%) and higher rates of satisficing (56.8% vs. 45.6%) in the WPP task ($p = .15$). When the effect of accountability within age groups was examined in each task, the only significant effect was for older adults in the WPP task, $X^2(2) = 6.73, p = .04$. More participants used noncompensatory strategies than satisficing in the high-accountability condition (50% vs. 26.8%), whereas the opposite was true in the low-accountability condition (42.5% vs. 70.7%). As can be seen in Table 4, the distribution of older adults across strategies in the WPP-high-accountability condition was similar to

Table 3. Search Characteristics as a Strategy Classification

Search attributes	PDP task			WPP task		
	Compensatory (<i>n</i> = 17)	Noncompensatory (<i>n</i> = 70)	Satisficing (<i>n</i> = 73)	Compensatory (<i>n</i> = 14)	Noncompensatory (<i>n</i> = 64)	Satisficing (<i>n</i> = 82)
Total study time (s)	287	287	181	207	218	120
Total cells viewed	91.9	123.1	60.4	101.6	107.5	46.3
Proportion of cells sampled	0.99	0.99	0.61	0.99	0.94	0.53
ARC attribute	0.08	0.47	0.49	0.02	0.47	0.51
ARC alternative	0.73	0.25	0.29	0.77	0.27	0.27

Notes. ARC = adjusted ratio of clustering; PDP = prescription drug plan; WPP = wireless phone plan.

Given that these search attributes were used by the algorithm to initially identify strategies and by us to subsequently further divide participants into those using noncompensatory and satisficing strategies, the observed differences across strategy types are not surprising and serve to validate the Riedl and colleagues (2008) algorithm.

Table 4. Percentage of Participants Within Each Age × Task × Accountability Condition Using Each Type of Strategy

Strategy	Younger adults				Older adults			
	High accountability		Low accountability		High accountability		Low accountability	
	PDP	WPP	PDP	WPP	PDP	WPP	PDP	WPP
Compensatory	9.8	14.6	15.8	10.5	10.0	7.5	7.3	2.4
Noncompensatory	48.8	46.3	34.2	36.8	50.0	50.0	41.5	26.8
Satisficing	41.5	39.0	50.0	52.6	40.0	42.5	51.2	70.7

Notes. PDP = prescription drug plan; WPP = wireless phone plan. Satisficing refers to those originally classified as using a satisficing strategy but engaging in limited information search. Noncompensatory refers to those initially classified as using satisficing but who also engaged in extensive information search.

that observed in both conditions in the PDP task. High motivation related to relevance or social accountability appears to have a disproportionate impact on older adults' engagement (e.g., relative shift from satisficing to higher levels of compensatory and noncompensatory information search in the WPP task).

Choice Justification and Strategy Use.—We next examined participants' choice justifications in an attempt to gain further insights into the complexity of processing and its relationship to age, motivation, and strategy use. We assessed the degree of integrative complexity utilizing a scale developed by Schroder, Driver, and Streufert (1967) used in research on social accountability (Tetlock, 1983) and decision making (Lee et al., 1999). Using a 9-point scale (1 = low differentiation and integration, 9 = high differentiation and integration), justifications were coded in terms of the degree to which individuals exhibited both differentiation among elements (e.g., identifying multiple attributes that were considered) and integration of these elements (e.g., considering trade-offs between different attributes). Two trained judges coded all participant responses—blind to age and accountability condition—and intraclass correlations revealed high levels of agreement: 0.94 for PDP, 0.82 for WPP. Mean scores from the two judges were examined as a function of age, accountability, and strategy type separately for each task (Table 5) because participants did not necessarily use the same strategies across tasks. Participants using compensatory and noncompensatory strategies exhibited similar scores that were higher than those of satisficers.

Thus, we combined these two groups for these analyses due to the relatively few participants using compensatory strategies.

For the PDP task, significant main effects were obtained for age, $F(1, 143) = 8.52, p = .004, \eta_p^2 = .06$, accountability, $F(1, 143) = 11.27, p = .001, \eta_p^2 = .07$, and strategy, $F(1, 143) = 6.38, p = .01, \eta_p^2 = .04$, with younger age, high accountability, and compensatory/noncompensatory strategy use being associated with greater complexity scores. For the WPP task, significant effects were obtained for age, $F(1, 144) = 9.73, p = .002, \eta_p^2 = .06$, accountability, $F(1, 144) = 4.23, p = .04, \eta_p^2 = .04$, and the interaction between accountability and strategy, $F(1, 144) = 4.09, p = .05, \eta_p^2 = .03$. This last effect was due to the effects of accountability being isolated to those using compensatory/noncompensatory strategies. Taken together, older adults exhibited lower levels of complexity than younger adults and complexity increased with accountability. Validating our separation of strategy types based on extensiveness of search, we also found that those identified as satisficers exhibited less complex reasoning than participants using other types of strategies. Importantly, although old age was associated with generally lower levels of complexity, similar relations between complexity and strategy use were observed across age groups.

Individual differences in strategy use.—Finally, we determined which participant characteristics might be most closely associated with strategy use, including age, education, task knowledge, task relevance, ability, PNS, and NFC.

Table 5. Mean Integrative Complexity Scores as a Function of Age, Accountability, Task, and Strategy Type

	PDP task				WPP task			
	Low accountability		High accountability		Low accountability		High accountability	
	Compensatory/ noncompensatory	Satisficing	Compensatory/ noncompensatory	Satisficing	Compensatory/ noncompensatory	Satisficing	Compensatory/ noncompensatory	Satisficing
Younger adults								
<i>M</i>	3.26	2.72	3.48	3.65	2.94	2.88	3.54	2.72
<i>SD</i>	1.07	1.03	1.05	1.25	1.01	1.21	1.08	0.98
Older adults								
<i>M</i>	2.68	2.21	3.48	2.53	2.18	2.43	2.80	2.53
<i>SD</i>	0.90	0.89	1.04	0.97	0.81	0.94	0.80	0.78

Note. *M* = mean; PDP = prescription drug plan; *SD* = standard deviation; WPP = wireless phone plan.

Using stepwise discriminant analyses within each task, the only variable making a significant contribution to the discriminant function was education. Canonical correlations with strategy type were significant for both tasks: PDP— $r = .24$, $p = .008$; WPP— $r = .23$, $p = .02$. Comparisons of strategy group centroids revealed significantly ($ps < .02$) higher function scores for the noncompensatory group (0.27) than either the satisficing (−0.14) or compensatory group (−0.48) in the PDP task. A similar trend was observed in the WPP task, where the noncompensatory (0.11) and satisficing (0.04) groups had significantly ($ps < .008$) higher scores than the compensatory group (−0.74). Thus, higher education was associated with extensive information search based on systematic use of preferences.

DISCUSSION

In an attempt to further our understanding of the impact of aging on decision making, we examined motivational influences on information search in a decision task. The results lend support to the notion that older adults are adaptive decision makers, flexibly adjusting their strategy use in response to task demands. Previous studies observed a relationship between aging and use of less complex search strategies, such as satisficing. We found that age differences in strategy use were not great, and the observed differences across age groups could be partially explained by motivational factors. Consistent with the notion of selective engagement (Hess & Queen, *in press*), older adults were more sensitive than younger adults to the self-implications of the task. Specifically, older adults' use of satisficing was greatest in a task of less relevance to their age group in a situation in which they were not held accountable. When self-presentation concerns or personal relevance was higher, older adults were more likely to engage in systematic search strategies. Strategy use in younger adults was less sensitive to these motivational factors. This disproportionate impact of motivational factors in later life is hypothesized to be an adaptive process related to the preservation of diminishing resources.

These findings are consistent with an emerging body of work in which older adults display adaptive decision

making. Although older adults may still exhibit deficits in certain contexts, research has demonstrated that they are sensitive to the demands of the task and adjust their behavior accordingly (Hess, Queen, & Patterson, 2012; Queen et al., *in press*; Mata, Schooler, & Rieskamp, 2007). They also adapt their decision processes to promote situational (e.g., Thomas & Millar, 2012) and personal goals (Löckenhoff & Carstensen, 2007) and effectively use knowledge to support both information search and decision outcomes (e.g., Johnson & Drungle, 2000; Meyer, Talbot, & Ranalli, 2007). In situations for which they possess relevant knowledge, older adults do quite well, in some cases demonstrating resistance to biases observed in younger adults (Kim & Hasher, 2005; Tentori, Osherson, Hasher, & May, 2001). Research on everyday problem solving echoes these findings, suggesting that the contextual relevance of the problem can attenuate age differences in problem-solving fluency and self-efficacy (Artistico, Cervone, & Pezzuti, 2003; Artistico, Orom, Cervone, Krauss, & Houston, 2010). Indeed, factors other than age may be more important determinants of performance in such situations. We found that the primary predictor of strategy use in this study was education level, not age, thereby replicating our previous findings (Queen et al., *in press*). The additional, more negative implication is that deficits in decision making in later life are more likely when knowledge cannot be used to scaffold performance or when motivation is low. This latter issue is not likely to be a factor in situations of personal importance, which are associated with high levels of engagement in older adults (Hess & Queen, *in press*).

This study also demonstrated that level of engagement in a decision-making task (e.g., amount of information sampled) is not necessarily associated with use of compensatory strategies. Research (Lee et al., 1999) has suggested that the motivation to make an effective decision increases use of such strategies. In our study, there was little evidence of this, with the majority of participants using some form of noncompensatory strategy. One explanation may have to do with the personal connection—either in terms of self-presentation concerns or personal relevance—that individuals had to the decision contexts used. This may not only motivate participants to engage in the task,

but also may increase reliance on preferences or previous experience to guide search. This is likely to increase the use of noncompensatory strategies, which have an attribute-based focus—presumably reflective of preference—as opposed to one based on alternatives. Although we did not assess decision quality, this result can also be seen as broadly consistent with theorizing about the use of heuristics in decision making (Gigerenzer, 2008) as adaptive strategies that often out-perform more logic-based search strategies. This is particularly true in situations involving intractable problems without clear optimal solutions.

It is important to note that, whereas use of noncompensatory strategies might suggest reliance on previous experience, their use does not necessarily reflect low levels of complex thought. When we divided those participants identified as using noncompensatory strategies into those engaging in more or less extensive search, we found a related trend with integrative complexity. As might be expected, participants engaging in satisficing with minimal information search exhibited relatively low levels of complexity in their reasoning about their decision. In contrast, those using a noncompensatory strategy *and* engaging in more extensive search exhibited significantly higher levels of complex thought that were on par with that exhibited by those using compensatory strategies. Whereas satisficing may reflect an extreme attempt at minimizing cognitive effort, engaging in systematic noncompensatory search seems to be an adaptive approach to reducing cognitive load while maintaining effective information acquisition.

Two general conclusions can be made from our results. First, we determined that task context is an important determinant of information search behaviors used to support decision making. The personal relevance of the task and degree to which individuals were required to justify their responses determined response to the task and the intensity of search behaviors. Of particular note is that these factors had a relatively greater impact on older adults' performance, suggesting that increasing age may be associated with heightened sensitivity to task context. This is consistent with the hypothesis that declining cognitive resources make older adults more sensitive to the costs of cognitive engagement, thereby increasing the salience of the self-related implications of the task. This subsequently results in increasing selectivity in the engagement of cognitive resources in later life (e.g., Hess & Queen, *in press*). It also suggests that age differences in aspects of decision making may be attenuated under task conditions that highlight personal relevance. Note that effects due to task content were obtained even though age differences in task-specific experience were smaller than expected. Thus, this study provided a conservative test of such effects. Second, high levels of engagement and personal resources (i.e., education) were not necessarily associated with increased use of compensatory strategies. Instead, elaborative noncompensatory strategies were more likely to be associated with these variables,

suggesting that such strategies are more adaptive to decision makers in familiar contexts, at least in terms of information search. Of course, the true adaptive nature would be reflected in quality of one's decision; however, by supplying actual content in the information matrices, we were not able to make determinations of choice quality.

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REFERENCES

- Artistico, D., Cervone, D., & Pezzuti, L. (2003). Perceived self-efficacy and everyday problem solving in young and older adults. *Psychology and Aging, 18*, 68–79. doi:10.1037/0882-7974.18.1.68
- Artistico, D., Orom, H., Cervone, H., Krauss, S., & Houston, E. (2010). Everyday challenges in context: The influence of contextual factors on everyday problem solving among young, middle-aged, and older adults. *Experimental Aging Research, 36*, 230–247. doi:10.1080/03610731003613938
- Bruine de Bruin, W., Parker, A. M., & Fischhoff, B. (2007). Individual differences in adult decision-making competence. *Journal of Personality and Social Psychology, 92*, 938–956. doi:10.1037/0022-3514.92.5.938
- Cacioppo, J. T., Petty, R. E., & Kao, C. F. (1984). The efficient assessment of need for cognition. *Journal of Personality Assessment, 48*, 306–307. doi:10.1207/s15327752jpa4803_13
- Chen, Y. (2004). Age differences in correction of context-induced biases: Source monitoring and timing of accountability. *Aging, Neuropsychology, and Cognition, 11*, 58–67. doi:10.1076/anc.11.1.58.29359
- Ennis, G. E., Hess, T. M., & Smith, B. T. (in press). The impact of age and motivation on cognitive effort: Implications for cognitive engagement in older adulthood. *Psychology and Aging*.
- Germain, C. M., & Hess, T. M. (2007). Motivational influences on controlled processing: Moderating distractibility in older adults. *Aging, Neuropsychology, and Cognition, 14*, 462–486. doi:10.1080/13825580600611302
- Gigerenzer, G. (2008). Why heuristics work. *Perspectives on Psychological Science, 3*, 20–29. doi:10.1111/j.1745-6916.2008.00058
- Henninger, D. E., Madden, D. J., & Huettel, S. A. (2010). Processing speed and memory mediate age-related differences in decision-making. *Psychology and Aging, 25*, 262–270. doi:10.1037/a0019096
- Hess, T. M., & Emery, L. (2012). Memory in context: The impact of age-related goals on performance. In M. Naveh-Benjamin & N. Ohta (Eds.), *Perspectives on memory and aging* (pp. 183–214). New York, NY: Psychology Press.
- Hess, T. M., Emery, L., & Neupert, S. D. (2012). Longitudinal relationships between resources, motivation, and functioning. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 67B*, 299–308. doi:10.1093/geronb/gbr100
- Hess, T. M., & Ennis, G. E. (2012). Age differences in the effort and costs associated with cognitive activity. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 67B*, 447–455. doi:10.1093/geronb/gbr12

- Hess, T. M., Germain, C. M., Rosenberg, D. C., Leclerc, C. M., & Hodges, E. A. (2005). Aging-related selectivity and susceptibility to irrelevant affective information in the construction of attitudes. *Aging, Neuropsychology, and Cognition, 12*, 149–174. doi:10.1080/13825580590925170
- Hess, T. M., Germain, C. M., Swaim, E. L., & Osowski, N. L. (2009). Aging and selective engagement: The moderating impact of motivation on older adults' resource utilization. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 64B*, 447–456. doi:10.1093/geronb/gbp020
- Hess, T. M., Leclerc, C. M., Swaim, E., & Weatherbee, S. R. (2009). Aging and everyday judgments: The impact of motivational and processing resource factors. *Psychology and Aging, 24*, 735–740. doi:10.1037/a0016340
- Hess, T. M., & Queen, T. L. (in press). Aging influences on judgment and decision processes: Interactions between ability and experience. In P. Verhaeghen & C. Hertzog (Eds.), *Emotion, social cognition, and everyday problem solving during adulthood*. Oxford, UK: Oxford University Press.
- Hess, T. M., Queen, T. L., & Patterson, T. (2012). To deliberate or not to deliberate: Interactions between age, task characteristics, and cognitive activity on decision-making. *Journal of Behavioral Decision Making, 25*, 29–40. doi:10.1002/bdm.711
- Hess, T. M., Rosenberg, D. C., & Waters, S. J. (2001). Motivation and representational processes in adulthood: The effects of social accountability and information relevance. *Psychology and Aging, 16*, 629–642. doi:10.1037/0882-7974.16.4.629
- Johnson, M. M. S. (1990). Age differences in decision-making: A process methodology for examining strategic information processing. *Journal of Gerontology: Psychological Sciences, 45*, 75–78. doi:10.1093/geronj/45.2.P75
- Johnson, M. M. S. (1993). Thinking about strategies during, before, and after making a decision. *Psychology and Aging, 8*, 231–241. doi:10.1037/0882-7974.8.2.231
- Johnson, M. M. S., & Drungle, S. C. (2000). Purchasing over-the-counter medications: The impact of age differences in information processing. *Experimental Aging Research, 26*, 245–261. doi:10.1080/0361073000404886
- Kim, S., & Hasher, L. (2005). The attraction effect in decision making: Superior performance by older adults. *Quarterly Journal of Experimental Psychology A, 58*, 120–133. doi:10.1080/02724980443000160
- Lee, H., Herr, P. M., Kardes, F. R., & Kim, C. (1999). Motivated search: Effects of choice accountability, issue involvement, and prior knowledge on information acquisition and use. *Journal of Business Research, 45*, 75–88. doi:10.1016/S0148-2963(98)00067-8
- Lerner, J. S., & Tetlock, P. E. (1999). Accounting for the effects of accountability. *Psychological Bulletin, 125*, 255–275. doi:10.1037/0033-2909.125.2.255
- Löckenhoff, C. E., & Carstensen, L. L. (2007). Aging, emotion, and health-related decision strategies: Motivational manipulations can reduce age differences. *Psychology and Aging, 22*, 134–146. doi:10.1037/0882-7974.22.1.134
- Mata, R., Schooler, L. J., & Rieskamp, J. (2007). The aging decision maker: Cognitive aging and the adaptive selection of decision strategies. *Psychology and Aging, 22*, 796–810. doi:10.1037/0882-7974.22.4.796
- Meyer, B. J. F., Talbot, A. P., & Ranalli, C. (2007). Why older adults make more immediate treatment decisions about cancer than younger adults. *Psychology and Aging, 22*, 505–524. doi:10.1037/0882-7974.22.3.505
- Mikels, J. A., Löckenhoff, C. E., Maglio, S. J., Carstensen, L. L., Goldstein, M. K., & Garber, A. (2010). Following your heart or your head: Focusing on emotions versus information differentially influences the decisions of younger and older adults. *Journal of Experimental Psychology: Applied, 16*, 87–95. doi:10.1037/a0018500
- Neuberg, S. L., & Newsom, J. (1993). Individual differences in chronic motivation to simplify: Personal need for structure and social-cognitive processing. *Journal of Personality and Social Psychology, 65*, 113–131. doi:10.1037/0022-3514.65.1.113
- Payne, J. W., Bettman, J. R., & Johnson, E. J. (1993). *The adaptive decision maker*. New York, NY: Cambridge University Press.
- Peters, E., Hess, T. M., Auman, C., & Västfjäll, D. (2007). Adult age differences in dual information processes and their influence on judgments and decisions: A review. *Perspectives on Psychological Science, 2*, 1–23. doi:10.1111/j.1745-6916.2007.00025
- Queen, T. L., Hess, T. M., Ennis, G. E., Dowd, K., & Grün, D. (in press). Search characteristics in a decision-making task: Age, complexity, and strategy-use. *Psychology and Aging*. doi:10.1037/a0028744
- Riedl, R., Brandstätter, E., & Roithmayr, F. (2008). Identifying decision strategies: A process- and outcome-based classification method. *Behaviour Research Methods, 40*, 795–807. doi:10.3758/BRM.40.3.795
- Riggle, E. D. B., & Johnson, M. M. S. (1996). Age difference in political decision making: Strategies for evaluating political candidates. *Political Behavior, 18*, 99–118. doi:10.1007/BF01498661
- Roenker, D., Thompson, C., & Brown, S. (1971). Comparison of measures for the estimation of clustering in free recall. *Psychological Bulletin, 76*, 45–48. doi:10.1037/h0031355
- Schaninger, C. M., & Sciglimpagalia, D. (1981). The influence of cognitive personality traits and demographics on consumer information processing. *Journal of Consumer Research, 8*, 208–216. doi:10.1086/208857
- Schroder, H. M., Driver, M. J., & Streufert, S. (1967). *Human information processing*. New York, NY: Holt, Rinehart and Winston.
- Sen, S., & Johnson, E. J. (1997). Mere-possession effects without possession in consumer choice. *Journal of Consumer Research, 24*, 105–117. doi:10.1086/209497
- Tentori, K., Osherson, D., Hasher, L., & May, C. (2001). Wisdom and aging: Irrational preferences in college students but not older adults. *Cognition, 81*, 87–96. doi:10.1016/S0010-0277(01)00137-8
- Tetlock, P. E. (1983). Accountability and complexity of thought. *Journal of Personality and Social Psychology, 45*, 74–83. doi:10.1037/0022-3514.45.1.74
- Thomas, A. K., & Millar, P. R. (2012). Reducing the framing effect in older and younger adults by encouraging analytic processing. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 67B*, 139–149. doi:10.1093/geronb/gbr076
- Verplanken, B., & Holland, R. W. (2002). Motivated decision making: Effects of activation and self-centrality of values on choices and behavior. *Journal of Personality and Social Psychology, 82*, 434–447. doi:10.1037/0022-3514.82.3.434
- Vieider, F. M. (2009). The effect of accountability on loss aversion. *Acta Psychologica, 132*, 96–101. doi:10.1016/j.actpsy.2009.05.006
- Ware, J. E., Jr. (1993). *SF-36 health survey*. Boston, MA: The Health Institute, New England Medical Center.
- Wechsler, D. (1997). *Wechsler adult intelligence scale* (3rd ed.). New York, NY: Psychological Corporation.
- Willemsen, M. C., & Johnson, E. J. (2011). Visiting the decision factory: Observing cognition with MouselabWEB and other information acquisition methods. In M. Schulte-Mecklenbeck, A. Kühberger, & R. Ranyard (Eds.), *A handbook of process tracing methods for decision research: A critical review and user's guide* (pp. 21–42). New York, NY: Psychology Press.