Age Differences in Trade-off Decisions: Different Strategies but Similar Outcomes

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RÉSUMÉ
L'objectif principal de cette étude était d'examiner les différences conditionnées par l'âge dans le traitement des stratégies de décisions émotionnellement difficiles. En outre, l'étude a testé les contributions pertinentes des mécanismes cognitifs et émotionnels à des différences dans le traitement de ces stratégies conditionnées par l'âge. Quarante jeunes adultes et quarante adultes plus âgés, en tout, ont été assignés au hasard soit à un niveau élevé ou à un niveau bas de difficulté émotionnelle qu'implique la décision d'acheter une automobile. MouselabWEB logiciel a été utilisé pour tracer les stratégies de traitement des partici- pants. Les résultats ont montré que les personnes âgées étaient plus susceptibles d'utiliser des stratégies de traitement basées sur les attributs, tandis que les jeunes adultes étaient plus susceptibles d'utiliser des stratégies de traitement basées sur des solutions de rechange à l'état très émotive. D'autre part, les jeunes adultes et les adultes plus âgés ont préféré utiliser des stratégies de traitement fondées sur des alternatives dans des conditions d'émotion faible. De plus, les résultats suggèrent que la mesure cognitive (c'est à dire, programmation de chiffres-symboles) n'était pas corrélée avec les effets de l'âge sur les stratégies de traitement.

ABSTRACT
The primary purpose of this study was to examine age differences in processing strategies of emotionally difficult trade-off decisions. In addition, the study tested the relevant contributions of the cognitive and emotional mechanisms to age differences in processing strategies. Altogether, 40 younger adults and 40 older adults were randomly assigned to either a high or low emotionally difficult condition of a car-purchasing decision task. MouselabWEB software was used to trace participants' processing strategies. Results showed that older adults were more likely to use attribute-based processing strategies, whereas younger adults were more likely to use alternative-based processing strategies in the high-emotion condition. In the low-emotion condition, on the other hand, both younger and older adults preferred to use alternative-based processing strategies. Furthermore, the results suggested that the cognitive measure (i.e., digit symbol coding) was not correlated with the age effects on processing strategies.

Manuscript received: / manuscrit reçu : 20/09/13

Manuscript accepted: / manuscrit accepté : 05/10/14

Mots clés : vieillissment, émotion, stratégies de traitement

Keywords: aging, emotion, processing strategies

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The ability to make choices among alternative courses of action lies at the heart of the decision-making process (Payne, Bettman, & Johnson, 1993). Within this process, it is the trade-offs among alternative choices that may be the most difficult aspect. Decision makers perhaps need to accept less of one attribute in order to achieve more of another. For example, when purchasing a car, people may have to make a trade-off between price and other desirable attributes of the car (e.g., safety, sound system, fuel efficiency). These types of decision tasks are often presented in the form of a matrix with different alternatives that have

doi:10.1017/S0714980815000033

specified attributes. For example, a car-purchasing decision task may be presented in a 3 × 3 matrix with three attributes (price, safety, and sound system), three alternatives (car A, car B, and car C), and seven possible attribute values (best, very good, good, average, poor, very poor, worst).

In the decision-making process, many strategies are characterized by three primary measures of information acquisition (Luce, Bettman, & Payne, 1997). The first measure is the amount of information processed. For instance, a decision maker could consider all relevant information, or merely a few pieces of data, to draw a conclusion. The second measure is whether information is acquired by selective processing or by consistent processing, across either attributes or alternatives. For example, if an individual is genuinely concerned about safety features when purchasing a car, then this individual may primarily focus on the safety attributes in the decision-making process. This, in turn, will lead the individual to buy a car with the best possible safety value within the desired choice range. The third measure of information acquisition is making a choice based on *alternative-based processing* or on *attribute-based processing.*

When individuals make a choice among multiple alternatives, for example, they may consider several attributes of a single alternative before processing the information of another alternative; this is known as an alternative-based strategy. Using the aforementioned car-purchasing example, for instance, when individuals first examine all the attribute values for car A, then move to car B, then to car C, they are engaging primarily in what we call *alternative-based processing*. On the other hand, with an attribute-based strategy, individuals engage in *attribute-based processing:* they compare the values of a single attribute – such as car safety – across several alternatives before processing the information of another attribute, such as car price.

Generally, attribute-based processing strategies avoid trade-offs. For example, the elimination-by-aspects (EBA) decision strategy is an attribute-based processing strategy in which options that do not meet the minimum cutoff value for the most important attribute are eliminated. This is followed by the second most important attribute and then the third; the process continues until only one option remains (Tversky, 1972). Depending on how quickly the final option is chosen when using the EBA strategy, this option will determine to what extent and degree of selectivity the cognitive processing will vary.

In contrast, alternative-based processing strategies usually consider trade-offs. For instance, the weighted additive strategy involves considering each alternative sequentially by multiplying every attribute value by its importance weight. Then, by summing all of the weighted attribute values, an overall value for each alternative may be computed (Keeney & Raiffa, 1976). Using this strategy, the alternative with the highest value would be chosen. The weighted additive strategy is alternative-based, and involves extensive and consistent information processing.

Previous research has extensively studied younger adults' processing strategies in various tasks (e.g., Luce et al., 1997; Payne, 1976; Reisen, Hoffrage, & Mast, 2008). Payne (1976) found that younger adults shifted from alternative-based strategies to attribute-based strategies when trade-off decisions became increasingly difficult – that is, with the increased number of alternatives and attributes, it became more difficult to make decisions. Participants used more attributed-based strategies to potentially cope with the increased decision difficulty. Further, in a trade-off decision, choice conflicts between one's important values can cause negative emotions (e.g., regretful, tense, worried, and concerned). Luce et al. manipulated the extents of the task-elicited negative emotions through attribute identities (e.g., occupant survival vs. routine handling) and the levels of conflicts of the attribute values. They found that when task-elicited negative emotions were increased, younger adults used more attribute-based, instead of alternative-based, processing. One possible explanation is that younger adults use attribute-based processing to minimize trade-offs and thus avoid the task-elicited negative emotions.

Despite the abundance of research on younger adults' processing strategies, there still remains a limited amount of research in regards to older adults' processing strategies in trade-off decisions. One exception is Johnson (1990), who studied how younger and older adults processed information. In Johnson's study, both younger and older adults chose a car from six alternatives that varied in nine attributes (e.g., fuel economy, interior roominess, safety record, etc.). In general, older adults were found to use less information but also to spend more time viewing information when making decisions. Additionally, older adults tended to use an attribute-based processing strategy: to examine all the data corresponding to a particular attribute across the alternative choices before switching to another attribute. In contrast, younger adults tended to examine all of the attributes of one car (i.e., using an alternative-based processing strategy) before examining another car. However, the underlying mechanism of the age effects on decision strategies in Johnson's study has not been explored.

Because of well-documented (e.g., Salthouse, 1991) age-related declines in cognitive functions, it has been suggested that cognitive mechanisms (e.g., working

https://doi.org/10.1017/S0714980815000033 Published online by Cambridge University Press

memory and processing speed) may be responsible for age differences in decision-making strategies (Chen & Sun, 2003; Henninger, Madden, & Huettel, 2010; Mata, Schooler, & Rieskamp, 2007). For example, Chen and Sun found that older adults tended to use simple heuristic strategies when making monetary decisions, perhaps to compensate for their reduced working memory capacities. In addition, Mata et al. found that, compared to younger adults, older adults tended to look up less information, take a longer time to process, and use less cognitively demanding strategies when asked to compare pairs of diamond prices. More importantly, they found that cognitive measures (i.e., forward digit span and digit symbol substitution) mediated age differences in information searches and processing strategies. Lower cognitive abilities were associated with simpler processing strategies.

The role of emotion in decision making has been less well studied in older adults. Socioemotional selectivity theory (SST; Carstensen, 1993; 1995) posits that with the perception of limited future time, older adults place increasingly more value on emotionally meaningful goals than do younger adults. Thus, relative to younger adults, older adults may be more motivated to pursue positive emotions and avoid negative emotions in social judgement and decision-making processes. In their study, Chen and Ma (2009) found that in a risk-taking task, the anticipated positive emotions (e.g., feeling of happiness when one takes risks that are followed by favorable outcomes) influenced older adults' risk-taking decisions. However, the anticipated negative emotions (e.g., feeling of regret if one does not take the risk and the outcome turns out to be positive) contributed to younger adults' risky decisions.

In a study about how younger and older adults choose health plans, Löckenhoff and Carstensen (2007) found that age affected decision making. Their results suggested that older adults were more likely to focus their attention towards positive information, whereas younger adults were more drawn to the negative aspects of the health plans. The age effects in this study were eliminated when future time perspective was controlled, and, although not directly tested, the study suggested the importance of age differences in emotion regulation. Furthermore, Mather, Knight, and McCaffrey (2005) found that older adults with high frontal lobe functions (e.g., working memory capacities, the ability to switch strategies) used more attribute-based processing strategies. However, younger adults with high frontal lobe functions used more alternative-based searching strategies. One possible explanation is that older adults use different decision strategies compared to younger adults to maximize positive emotions and avoid negative emotions in the decision-making process. If this is the case, then older adults with higher frontal lobe functions would be the most capable of applying processing strategies that would reduce the conflict and negative emotions elicited from trade-offs. However, the direct link between processing strategies and negative emotions was not tested in this study.

Present Study: Purpose

The primary purpose of the present study was to examine age differences in processing strategies of emotionally difficult decisions, as well as to explore the underlying mechanism (i.e., emotional and/or cognitive) for this age effect through randomly assigning participants to one of the decision-making tasks (a high-emotion difficult condition versus a low-emotion difficulty condition). The high-emotion difficulty condition would elicit more negative emotions than the low-emotion condition. We used attribute identity to manipulate the emotion difficulty conditions. For example, for our car-purchasing task, we used the attributes of occupant survival and pollution caused for the high-emotion difficulty condition. On the other hand, we used the attributes of routine handling and recycling potential for the low-emotion difficulty condition.

We used MouselabWEB software (Willemsen & Johnson, 2006) to present a car-purchasing decision-making task to select one out of a possible four cars in a 4 × 4 matrix on a computer screen. Rows represented four attributes, columns represented the four alternatives, and each cell contained the attribute value (seven possible values: 1 = worst, 7 = best). The order of the four cars was counterbalanced across conditions. Participants first read the descriptions of the car-purchasing task and the meaning of each attribute (all of the attribute values were masked). Then, participants used the computer mouse to uncover the hidden information. As soon as the mouse was moved over an attribute cell, the value was displayed. When participants moved the mouse out of the cell, the value was hidden again. MouselabWEB recorded the order of the cells being opened, the processing time, and the number of cells opened. After studying the 4 × 4 matrix, participants were asked to choose one out of the four cars to purchase.

Based on previous research and the SST, we had three major hypotheses. Hypothesis 1 was that, across the two decision task conditions, older adults would open fewer cells and take a longer time to make decisions than do younger adults. Hypothesis 2 was that, as the high-emotion condition decision task was more difficult than the low-emotion condition decision task, both older and younger adults would open more cells and spend more time in the high-emotion condition compared with the low-emotion condition. Finally, hypothesis 3 was that there would be an interaction effect of age group and emotion condition on processing strategies. Specifically, in the high-emotion condition, in contrast with younger adults, older adults would be more likely to use attribute-based processing strategies to avoid the task-elicited negative emotions. However, younger and older adults both would use similar processing strategies (i.e., an alternative-based processing strategy) in the low-emotion condition. Furthermore, since previous research suggested both cognitive and emotional measures could possibly account for the age effects in decision strategies, both mechanisms were examined, and without a specific hypothesis in regards to the underlying mechanism of the age effects.

Previous research has reported contrarian findings with respect to age differences in decision outcomes (e.g., Bruine de Bruin, Parker, & Fischhoff, 2010; Wood, Busemeyer, Koling, Cox, & Davis, 2005). For example, Wood et al. found that older and younger adults adopted very different strategies; however, both age groups solved the Iowa gambling task successfully. On the other hand, Bruine de Bruin et al. indicated negative relations between age and performance on Resistance to Framing and Applying Decision Rules tasks using the Adult Decision-Making Competence (A-DMC) measure. Considering the inconsistent previous findings, we made no specific hypothesis regarding age and decision-making outcomes.

Methods

Participants

The younger adult group consisted of 40 undergraduate students (18 males), ranging in age from 18 to 25 years old ($M = 19.68$, $SD = 1.56$). They were recruited from undergraduate psychology classes at a large midwestern university in exchange for extra credits. Fifty per cent of the younger adults were White, 27.5% were African-Americans, and 10% were Hispanic Americans. Forty older adults (14 males) participated in the current study, ranging in age from 60 to 88 years old ($M = 71.03$, $SD = 8.17$). They were recruited from local senior centers and were paid $10 each for participation. Eighty-three per cent of older adults were White, and 10% were Asian Americans. Older adults reported more years of education than younger adults [older: $M = 15.42$, $SD = 3.73$; younger: $M = 14.04$, $SD = 1.22$; (1, 71) = 4.9, $p < .05$]. No age differences were found for self-reported health status (1 = poor, 2 = fair, 3 = good, 4 = excellent; older: $M = 2.98$, $SD = .83$; younger: $M = 3.20$, $SD = .61$).

Car-Purchasing Task

The present study used a car-purchasing task similar to the one in Luce et al.'s (1997) study. Car attribute identity was manipulated to control the level of task-elicited negative emotions. In the high- versus low-emotion condition, the two pairs of car attributes – that is, occupant survival (high) versus routine handling (low), pollution caused (high) versus recycling potential (low) – both had high importance ratings, but the car attributes from the high-emotion condition had higher perceived loss aversion ratings than the corresponding car attributes from the low-emotion condition (see Appendix A).

To select appropriate car attributes for younger and older adults, we conducted a pilot study with 60 undergraduate students between 17 and 27 years old ($M = 20.55$, $SD = 1.68$) and 30 older adults between 62 and 84 years old ($M = 70.13$, $SD = 5.37$). For the car-purchasing task, we chose 15 car attributes from *Consumer Reports* magazine and other similar sources. Attributes included, for example, *occupant survival*, *routine handling*, and *interior roominess*. Each attribute value ranged from worst to best (on a 7-point scale, 1 = worst, 7 = best), with worst being the least desirable value of the attribute and best being the most desirable value of the attribute. Participants were asked how important each attribute was in their decision to purchase a new car. The importance rating scale ranged from 1 (not important at all) to 7 (very important). For the perceived loss aversion measures, participants were first informed that they had the best value for each attribute, and then they were asked to rate how reluctant they would be to give up a best value for a worst value of each attribute. The scale of this measure ranged from 1 (not reluctant at all) to 7 (very reluctant).

We applied three criteria to select the two pairs of attributes for the low- versus high-emotion condition for both younger and older adults: first, that no age differences were presented in the importance and loss aversion measures; second, that the importance ratings for each pair of attributes were similar; and third, that for each pair of attributes, the attribute in the high-emotion condition had higher loss aversion scores than the attribute in the low-emotion condition. Multivariate tests were performed to analyze age differences in the 15 car attributes. The results showed that across the two measures – importance and loss aversion – with the exceptions of *sound system*, *style*, and *domestic content* ($Fs > 2.30$, $ps < .05$), the remaining 12 attributes did not show any differences in the age groups. Paired t-tests showed that participants were more reluctant to give up a best value for a worst value for *occupant survival* and *pollution caused* compared to *routine handling* and *recycling potential* ($ps < .05$). Paired t-tests also showed that both *occupant survival* and *pollution caused* were rated more important than *routine handling* and *recycling potential* ($ps < .05$). Although the first attributes were rated as being significantly more important than the second attributes in the two pairs, the means

https://doi.org/10.1017/S0714980815000033 Published online by Cambridge University Press

of the importance rating of the second attributes were both above four. Therefore, for the current study, we selected the following two pairs of attributes: *occupant survival* versus *routine handling* and *pollution caused* versus *recycling potential*.

In addition, two more attributes, *price* and *interior roominess*, were kept constant in both conditions to keep the car-purchasing task sufficiently complex (see Appendix A). The average inter-attribute correlation (the averaged correlation of the possible paired attributes correlations within each condition, which was calculated using the attribute numerical values across the four cars) was –.17 in the low-emotion condition, and the average inter-attribute correlation was –.27 in the high-emotion condition. Thus, the high-emotion condition had a higher attribute conflict than the low-emotion condition, which made the trade-offs among the attributes in the high-emotion condition more difficult.

Assessing Processing Strategies

We used the information recorded by the MouselabWEB to create the dependent variables and determined the processing strategy by the order of the information box being opened. If participants checked one information box, there were three possibilities for their next acquisition. First, if participants moved the mouse along the horizontal line, they were presented with the same alternatives but different attributes (this was an *alternative-based transition*). Second, if participants moved the mouse along the vertical line, they too were presented with the same attributes but different alternatives (in an *attribute-based transition*). The third possibility for information acquisition occurred if participants moved the mouse along the diagonal line: these participants were presented with different alternatives and different attributes (in a *mixed transition*). Only the first two transitions were considered, however, because we could not describe the third case as either attribute-based or alternative-based searching; accordingly, we omitted it from further analysis.

Using the same method as Luce et al. (1997) had, we calculated the processing strategy index score by subtracting the number of attribute-based transitions from the number of alternative-based transitions, and then divided by the total number of attribute-based and alternative-based transitions. Thus, the processing strategy index score ranged from –1 to 1, with the negative values associated with more attribute-based processing and positive values associated with more alternative-based processing.

Attribute Importance Ratings

Participants were also asked to rate how important each attribute was to their decisions (1 = not important at all, 5 = extremely important). This measure was later used to explore the outcome of participants' decisions.

Retrospective Emotion Measures

We adapted the retrospective emotion measures for this study from the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988; Watson & Tellegen, 1985). Immediately after participants made their choices, they were presented with an adjective checklist, with 11 negative emotions (e.g., regretful, irritable, troubled, worried, etc.) and five positive emotions (e.g., happy, peaceful, confident, etc.). Participants were asked to indicate how well each adjective described the way they had felt while making their decisions (1 = not well at all, 5 = extremely well).

Digit Symbol Coding

We used the digit symbol coding subtest of the Wechsler Adult Intelligence Scale (WAIS)-III to measure participants' processing speed capacities and also their working memory capacity (Joy, Kaplan, & Fein, 2004). In addition, the digit symbol coding subtest served as a screening test for neuropsychological dysfunction; the impairment of any contributing ability for this test results in a low score (Joy et al., 2004). Participants had to follow a scheme relating a set of symbols to digits by writing as many symbols as possible corresponding to the digits within one minute. The coefficient of the digit symbol coding test was .84.

Design and Procedures

Our study used a two-by-two between-subject design; that is, we had two age groups (younger versus older adults) and two emotion conditions (high versus low). Each participant was tested, one-on-one, by an experimenter. First, participants went through two training trials using the mouse to uncover the hidden attribute values. Then, they completed the car-purchasing task (they could take as much time as they wanted as there was no time limitation on the task) and rated their emotions. Finally, they finished the digit symbol coding task and filled out the demographic questionnaire. At the end of the study, participants were fully debriefed and thanked for their participation.

Results

Preliminary Analysis and Manipulation Check

To measure retrospective emotions elicited by the decision task, we applied 11 negative adjectives and 5 positive adjectives. The Cronbach's alpha obtained for the negative emotions measure was .89. A two-way ANOVA was performed with averaged negative

https://doi.org/10.1017/S0714980815000033 Published online by Cambridge University Press

emotions serving as the dependent variable and emotion condition (low versus high) and age group (younger versus older) as the independent variables. The results showed that the interaction effects of age group and emotion condition on retrospective negative emotion was not significant; $F(1, 69) = .32$, $p = .57$. However, both the main effects of emotion condition and age group were significant. Specifically, both younger and older adults reported higher retrospective negative emotion in the high-emotion condition than in the low-emotion condition [low: $M = 1.74$, $SD = .67$; high: $M = 2.06$, $SD = 1.08$, $F(1, 69) = 4.48$, $p < .05$, $\eta^2_p = .06$]. Furthermore, younger adults ($M = 2.07$, $SD = .66$) reported higher negative emotions than older adults ($M = 1.72$, $SD = .67$) across the two emotion conditions; $F(1, 69) = 5.26$, $p < .05$, $\eta^2_p = .07$.

The Cronbach's alpha obtained for the five positive emotion adjectives was .71. A 2(emotion condition: low versus high) by 2 (age group: younger versus older) ANOVA was conducted on the averaged retrospective positive emotion. Both the age group by emotion condition interaction effect and the age group main effect were not significant. However, the main effect of emotion condition was significant; $F(1, 74) = 7.40$, $p < .01$, $\eta^2_p = .09$. Participants reported higher retrospective positive emotion in the low-emotion condition ($M = 3.65$, $SD = .69$) than in the high-emotion condition ($M = 3.20$, $SD = .73$).

Age Differences in Processing Strategies

The MouselabWEB software recorded how many cells in total (counting the re-opened cells) participants viewed before making their final decisions and how much time they spent in making their decisions. To test hypotheses 1 and 2, a 2 * 2 ANOVA – with two age groups (younger vs. older adults) and two emotion conditions (high vs. low) – was performed on total number of cells opened, processing time, and average processing time (processing time divided by total number of cells opened).

Table 1 presents the means and standard deviations of total number of cells opened, processing time, average processing time, and processing strategy index score by each age group and collapsed across age groups for the low versus high emotion condition. None of the interaction effects of age group and emotion condition on total number of cells opened, processing time, and average processing time were significant. What we did find significant, however, were the main age effects of total cells opened [$F(1, 76) = 5.4$, $p < .05$, $\eta^2_p = .07$], processing time [$F(1, 76) = 42.05$, $p < .0001$, $\eta^2_p = .36$], and average processing time [$F(1, 76) = 11.39$, $p < .05$, $\eta^2_p = .13$]. Older adults took more time, opened more cells, and spent more time in each cell in the decision-making process than younger adults did. Hypothesis 1 stated that older adults would open fewer cells and take longer time to make decisions than younger adults. Thus, hypothesis 1 was partially supported as older adults took a longer time to decide than did younger adults. However, instead of viewing less information, older adults viewed more information than younger adults did.

In addition, the main condition effects of total number of cells opened [$F(1, 76) = 9.07$, $p < .01$, $\eta^2_p = .11$] and processing time [$F(1, 76) = 12.29$, $p < .01$, $\eta^2_p = .14$] were both significant. Both younger and older adults opened more cells and took more time to process in the high-emotion condition than in the low-emotion condition. Hypothesis 2 stated that both older and younger adults would open more cells and spend more time in the high-emotion condition compared with the low-emotion condition. Hence, hypothesis 2 was supported.

In order to test hypothesis 3, which indicated that there would be an interaction effect of age group and emotion condition on processing strategies, a two-way ANOVA by age group (younger versus older) and emotion condition (low versus high) was conducted on processing strategy index scores. A marginally significant age group by emotion condition interaction

Table 1: Means and standard deviations of the total number of cells opened, processing time (in seconds), average processing time (processing time divided by total number of cells opened), and processing strategy index score for the car decision task

	Younger Adult				Older Adults				Total			
	Low (n=18)		High (n=22)		Low (n=21)		High (n=19)		Low (n=39)		High (n=41)	
Dependent Measures	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Total Number of Cells Opened	28.28	11.66	42	21.86	39.05	17.27	51.11	22.8	34.08	15.73	46.22	22.49
Processing Time	30.89	12.69	49.9	19.66	68.17	30.24	94.12	50.42	50.96	30.13	70.39	42.95
Average Processing Time	1.12	0.43	1.28	0.43	2.09	1.71	1.81	0.53	1.67	1.36	1.53	0.54
Processing Strategy index score	0.06	0.30	0.12	0.25	0.10	0.39	-0.07	0.30	0.08	0.35	0.03	0.29

M **= mean**
SD **= standard deviation**

effect was found; $F(1, 76) = 2.55$, $p = .11$, $\eta^2_p = .03$. Since older adults reported more years of education than younger adults, we conducted an ANCOVA test to control for years of education. Results suggested a marginally significant interaction effect by age group and emotion condition with a more significant p value ($p = .088$) than the previous ANOVA test results – ($p = .11$), [$F(1, 68) = 3.00$, $p = .088$, $\eta^2_p = .04$] – which provided more evidence for hypothesis 3.

In the high-emotion condition, older adults were more likely to use attribute-based, and younger adults were more likely to use alternative-based, processing strategies (older: $M = –.07$, $SD = .30$; younger: $M = .12$, $SD = .25$; $F(1, 39) = 4.47$, $p < .05$, $\eta^2_p = .10$). No age differences in processing strategies were found in the low-emotion condition (older: $M = .10$, $SD = .39$; younger: $M = .06$, $SD = .30$; $F(1, 37) = .14$, $p = .71$). Specifically, both younger and older adults were more likely to use alternative-based processing strategies in the low-emotion condition. Thus, our results indicated a trend that there was an age-group-by-emotion-condition interaction effect, and this partially supported hypothesis 3.

Processing Strategies and Cognitive Abilities

For the digit symbol coding task, there was a significant age effect as younger adults ($M = 42.33$, $SD = 6.73$) performed better on the task than did older adults; $M = 28.16$, $SD = 7.01$; $F(1, 74) = 80.81$, $p < .001$, $\eta^2_p = .52$. A correlation test between digit symbol coding and processing strategy index scores indicated that there was no significant relationship between these two variables; $r(76) = –.105$, $p = .37$.

Exploring Age Differences in Decision Outcomes

Keeney and Raiffa (1976) suggested that the weighted additive decision strategy was the classic model of normative decision making. This strategy identifies the choice with the maximum utility and involves thorough and compensatory decision processing (by explicitly considering trade-offs). In the current study, the importance rating of each attribute was multiplied by the corresponding attribute value (1 = worst, 7 = best). Then, the weighted values were summed across each alternative choice. The alternative with the highest score, and hence, the maximum utility, was chosen as the best outcome. Participants who selected the choice with the maximum utility were coded as 1; participants who did not select the choice with the maximum utility were coded as 0. Logistic regression was performed using the binary variable selection of maximum utility choice (select or not select), as the dependent variable, and age group and emotion condition as the independent variables.

The results indicated that only the emotion condition effect was significant; $\chi^2(1, n = 79) = 14.3$, $p < .0001$. Participants were more likely to select the choice with the maximum utility in the low-emotion condition than in the high-emotion condition. Contrary to general beliefs, younger adults were no more accurate than were older adults in selecting the choice with the maximum utility.

Discussion

In this study, we examined age differences in processing strategies with trade-off decisions. We found that when the trade-off decision tasks elicited more-negative emotions, older adults tended to use attribute-based processing strategies, whereas younger adults tended to use an alternative-based approach. In addition, older adults opened more cells to view information and spent more time to make decisions than did younger adults.

To the best of our knowledge, the present study is the first of its kind to examine age differences in processing strategies with trade-off decisions, in which task-elicited negative emotions were manipulated. The current study yielded results similar to earlier research conducted by Johnson (1990), finding that older adults processed information through the use of attributes whereas younger adults favored an alternative-based processing strategy when reaching their decisions. Later research by Johnson (1993, 1997) and Hartley (1989) failed to replicate the earlier findings (Johnson, 1990) regarding age differences in processing strategies. The conflicting results may be due to the different decision-making materials and tasks used in those studies. For example, Johnson (1990) used a car-purchasing task with six cars and nine car attributes whereas Johnson (1993) used an apartment-renting decision task with five apartments and 11 apartment attributes. Similarly, in the present study, age differences in processing strategies tended to be in the high-emotion condition, but no age effects in processing strategies were found in the low-emotion condition.

It has been suggested that age differences in decision making can be explained by cognitive capacities. Indeed, Mata et al. (2007) found that older adults used less cognitively demanding strategies than younger adults when comparing pairs of diamond prices. Furthermore, cognitive measures (i.e., forward digit span and digit symbol substitution) mediated age differences in processing strategies. Our study tested both the cognitive mechanism and an alternative mechanism (i.e., negative emotions elicited by trade-off decisions) underlying age differences in processing strategies. Older adults reported lower retrospective negative emotions than did younger adults in the high-emotion condition and were more likely to engage in attribute-based processing. Consistent with the SST (Carstensen, 1993; 1995), this finding suggested that older adults might use attribute-based strategies in decision making to reduce the negative emotion elicited by difficult trade-off decisions. However, the current study found no relationship between the cognitive measure (digit symbol coding) and the processing strategy index score. One possible explanation could be that the current study did not demand high levels of cognitive resources for both younger and older adults. Thus, for future studies, in order to sufficiently examine the cognitive hypothesis regarding age differences in processing strategies, varying the complexity of the decision tasks is essential.

Hanoch, Wood, and Rice (2007) pointed out that older adults are "emotional satisficers" (p. 350) and younger adults are "cognitive satisficers" (p. 352). Specifically, older adults tend to focus on emotional cues in a decision-making task; on the other hand, younger adults tend to search for factual information. This may explain why younger and older adults had different reactions when their negative emotions were elicited during the decision-making process. Older adults may have had the goal of minimizing negative emotions, whereas younger adults reacted by engaging in more comprehensive processing strategies (i.e., alternative-based strategies) to increase the accuracy of their choices. This explanation is consistent with another study conducted by Chen, Ma, and Pethtel (2011) in which they found that older adults preferred to defer choices when an influx of negative emotions was elicited by the decision-making task. This finding may indicate that older adults used choice deferral as a strategy to minimize the task-elicited negative emotions. However, Luce et al. (1997) found that when task-elicited negative emotions were substantially increased, younger adults preferred more attribute-based processing as well. This could be due to the extent of the task-elicited negative emotions. That is, older adults might be more sensitive to negative emotions whereas younger adults might have a higher threshold for negative emotions. When there are more task-elicited negative emotions, younger adults might first try to use more alternative-based processing to increase the accuracy of the decision; when the negative emotions rise to a certain level, younger adults might prefer more attribute-based processing to cope with the negative emotions.

Frisch and Clemen (1994) have suggested that the degree to which the process is extensive (by viewing more information) and the degree to which it attempts to resolve trade-offs between attributes (by compensating) are two important aspects of a normatively accurate decision-making process. The weighted additive strategy is both extensive and compensatory; hence, it is considered to be the classical model of normative decision making (Keeney & Raiffa, 1976). The present study explored whether or not choice accuracy – that is, participants selected the choice with the maximum utility value – could be predicted by age group and emotion condition. The results indicated that participants in the low-emotion condition were more likely to select the choice with the maximum utility value than participants in the high-emotion condition. No age differences, however, were found in selecting the choice with the maximum utility value. It seems that although older adults used more attribute-based processing strategies, their decision accuracy was similar to that of younger adults.

Previous studies about aging, processing strategies, and decision outcomes have yielded mixed results. Chen and Sun (2003) found that older adults selected simpler strategies in a monetary decision task; however, their decisions were as effective as those of younger adults. Kim and Hasher (2005) revealed that older adults tend to be more consistent in their decisions than their younger counterparts. Interestingly, however, Löckenhoff and Carstensen (2007) found that older adults were more likely to make inconsistent choices than younger adults when choosing health plans. A recent study by Samanez-Larkin, Kuhnen, Yoo, and Knutson (2010) also suggested that older adults made more suboptimal choices than did younger adults in financial risk-taking decision tasks.

The results of the present study indicated that older adults were as accurate as younger adults when choosing the alternatives with maximum utility, in accordance with their individual perspectives of attribute importance. The conflicting findings of the previous research may be resolved by systemically examining the combination of the nature of the decision-making tasks (e.g., how information is presented, and the type and extent of emotions elicited), and the characteristics of the decision maker (e.g., decision goals, decision strategies, and familiarity with the decision task).

The contribution of the current study should be addressed with the following limitations in mind. First, older and younger adults may have had different levels of negative emotions before they performed the decision-making task (Carstensen, Mikels, & Mather, 2006). Thus, in future studies, researchers should measure baseline emotions. Second, since we conducted our study in a laboratory setting, the mean of retrospective negative emotion was below the midpoint of the scale (1 = not negative at all, 5 = extremely negative). Real-life decision making may have greater self-relevance, elicit stronger emotions, and carry more-serious consequences. Future researchers examining age differences in processing strategies need to study decisions in real-life settings, involving medical or financial decision making, for example. Third, our current study found that older adults spent more time processing in the high-emotion condition compared to the low-emotion condition, which could have potentially depleted their cognitive resources, and led to a more attribute-based processing strategy as it was considered less cognitively demanding. To test the alternative explanation for the current finding, it will be important to include various cognitive measures in future studies in order to be able to conduct mediation analyses. Fourth, the participants of the current study were students and community-dwelling older adults. To generalize the findings, future studies should ensure a more diverse and representative sample.

The findings of the present study not only add to our understanding of age differences in processing strategies but also have important implications in older adults' everyday decision making. For example, in 2006, a new prescription drug plan (the Medicare Part D program) for older adults was introduced in the United States, which offered approximately 50 different drug plans to choose from (Kaiser Family Foundation, 2009). Choosing the best plan could save older adults hundreds or even thousands of dollars each year (Gruber, 2009). However, choosing among 50 different drug plans could be a challenging task for older adults facing age-related cognitive decline. Older adults should be given ample time to review all information for health plans to arrive at the optimal decision. In addition, professional consultants should also encourage and advise older adults to adopt decision strategies that will maximize their benefits.

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Appendix A I. Car-purchasing task (low-emotion condition)

Attributes/Cars	Price	Routine Handling	Interior Roominess	Recycling Potential
Car A	Very poor	Very good	Average	Very good
Car B	Average	Average	Best	Poor
Car C	Best	Worst	Very Poor	Average
Car D	Worst	Best	Poor	Worst

Note: **Attributes are all scaled on a 7-point scale ranging from best to worst, with best indicating the most desirable value for the attribute and worst indicating the least desirable value for the attribute.**

II. Car-purchasing task (high-emotion condition)

Attributes/Cars	Price	Occupant Survival	Interior Roominess	Pollution Caused
Car A	Very poor	Very good	Poor	Average
Car B	Average	Average	Best	Poor
Car C	Best	Worst	Very Poor	Average
Car D	Worst	Best	Average	Very Poor

Note: **Attributes are all scaled on a 7-point scale ranging from best to worst, with best indicating the most desirable value for the attribute and worst indicating the least desirable value for the attribute.**
The orders of the cars were counterbalanced across conditions. Only one of the orders of the high- vs. low-emotion conditions was shown here.

https://doi.org/10.1017/S0714980815000033 Published online by Cambridge University Press