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I Owe You: Age-Related Similarities and Differences in Associative Memory for Gains and Losses

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Abstract

Older adults often experience associative memory impairments but can sometimes remember important information. The current experiments investigate potential age-related similarities and differences associate memory for gains and losses. Younger and older participants were presented with faces and associated dollar amounts, which indicated how much money the person "owed" the participant, and were later given a cued recall test for the dollar amount. Experiment 1 examined face-dollar amount pairs while Experiment 2 included negative dollar amounts to examine both gains and losses. While younger adults recalled more information relative to older adults, both groups were more accurate in recalling the correct value associated with high value faces compared to lower value faces and remembered gist-information about the values. However, negative values (losses) did not have a strong impact on recall among older adults versus younger adults, illustrating important associative memory differences between younger and older adults.

Keywords

memory; aging; associations; selectivity; gains and losses

Older adults often experience a variety of episodic memory impairments (Craik & Salthouse, 2007; Zacks & Hasher, 2006). This appears to be most pronounced when attempting to remember new associations, such as name-face pairings (e.g., James, 2006; Naveh-Benjamin, Guez, Kilb, & Reedy, 2004) or face-face pairings (e.g., Rhodes, Castel, & Jacoby, 2008). The observation and relative consistency of this type of finding has led to the suggestion of an associative deficit hypothesis (Naveh-Benjamin, 2000; Old & Naveh-Benjamin, 2008), and this hypothesis has been supported in a number of tasks and settings (e.g., Castel & Craik, 2003; Chalfonte & Johnson, 1996). However, people may be motivated to remember important financial information, especially if doing so has a high payoff. For example, someone might well-remember that she lent someone $10,000 so as to collect that money later, or someone may be very aware of an outstanding credit card bill that needs to settle in the near future.

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[1]In the analysis of estimated values, some participants did not provide guesses on all trials. These trials were treated as missing in all of the reported analyses.

[2]In terms of statistical significance, the results are the same when binning the owed values.

While the associative deficit is most pronounced when older adults have to remember unrelated units of information (e.g., unrelated word pairs), this deficit is reduced when information has some meaningful connection (e.g., related word pairs; Naveh-Benjamin, 2000). There are also instances where older adults can remember certain associations, such as binding conceptual or emotional information (as opposed to perceptual information) with a source (e.g., May, Rahhal, Berry, & Leighton, 2005; Rahhal, May, & Hasher, 2002) or remembering market-value (realistic) prices of grocery items, relative to unrealistic prices (Castel, 2005). Thus, there are cases and situations where older adults can remember associations accurately, often when the association has some degree of increased relevance or semantic and schematic support (Naveh-Benjamin, 2000; Castel, 2005; Craik & Bosman, 1992).

Prior work has suggested that memory performance can be strongly influenced by the value or reward associated with remembering certain target information (such as point values or rewards associated with remembering information, e.g., Adcock et al., 2006, Castel et al., 2002; Festini, Hartley, Tauber & Rhodes, 2013; McGillivray & Castel, 2011; Murayama & Kuhbandner, 2011). Although a number of studies have shown that people (children, younger and older adults) will typically remember more information paired with higher point values than lower point values (see Castel, McGillivray & Friedman, 2012, for a review), Madan and Spetch, (2012) found that younger adults show a U-shaped recall function, recalling high-value items (reflecting reward processes) but also lowest–value items (due to the salience of these items at the lowest end of the scale). However, this has not yet been examined among older adults. In addition, other research suggests that younger adults attend to both potential rewards and losses associated with certain information, whereas older adults may show differential processing of gains relative to losses (cf., Castel, Farb, & Craik, 2007; Samanez-Larkin et al., 2007), though this literature is somewhat mixed in that other work has shown opposite, or null effects of age (see Eppinger, Hämmerer, & Li,, 2011, for a recent review).

In the present study, we examined how younger and older adults recalled values (in the form of monetary values) that were associated with faces, to determine how value guides what is remembered by younger and older adults, and if both younger and older adults would selectively focus on remembering associations with higher versus lower values. This implies that both groups can and do rely on value to guide associative memory processes, and value information is retained when later presented with cues (in this case, faces). In Experiment 1, participants were told they would study faces and each face would be paired with a monetary value, ranging from 0 to $100. The dollar amount reflected how much money the person owed the participant, and thus it was important to remember accurately the values in order to later “collect” from the person (i.e., the participant wanted to collect as much money as possible). At test, participants were presented with each face and asked to recall the associated value. In Experiment 2, we examined this in more detail by including faces associated with both gains and losses (e.g., these faces were associated with a dollar amount that reflected how much money the participant owed to the person, thus representing a loss). Here, potential gain occurs when a target face owes the participant money and potential loss occurs when the participant owes money to the target face in question. Some but not all prior work has found less sensitivity to losses among older adults (Samanez-Larkin et al., 2007;

Eppinger, Hämmerer, & Li, 2011). Thus, further work is needed to clarify the conditions under which age-related effects will emerge. In addition, prior work has not specifically examined associative memory for potential gains and losses, something that has especially important consequences for older adults who often express concern over declines in associative memory.

Older adults may selectively attend to faces associated with positive outcomes, similar to the positivity effect for emotional information (Mather & Carstensen, 200). Recent research has demonstrated significant age-related changes in motivation that, in addition to changes in cognitive performance, influence how older (vs. young) adults attend to information (e.g. Isaacowitz, Charles, & Carstensen, 2000). Specifically, older adults place a heavier emphasis on personal values and experiences. This emphasis leads them to focus more on emotion (see Labouvie-Vief & Blanchard-Fields, 1982). One motivation-based reason for older adults' increased emphasis on emotion is provided by Carstensen's (1992) Socioemotional Selectivity Theory (SST). According to SST, older adults devote more effort to deriving emotional meaning and are more focused on affective gain (positive emotion) and avoiding affective loss (negative emotion). Indeed, older adults' decision-making is especially influenced by the desire to avoid negative emotion. For example, older adults seek less variety when making choices for future versus immediate consumption in order to avoid choices that might negatively impact their current emotional state (Novak & Mather, 2007). Older adults also tend to avoid negative emotional information when processing advertisements (Williams & Drolet, 2005). In summary, the above findings and others (e.g., Drolet, Lau-Gesk & Scott, 2010) indicates that age-related differences in cognitive, social, and motivational processes play a role.

In the present study, we were especially interested in whether value would guide recall performance, such that participants remembered the associated value for the high-paying faces in Experiment 1. Experiment 2 examined whether this would also be the case for high-loss faces, allowing for some theoretical and practical insight regarding potential age differences in how younger and older adults remembered positive (gain) and negative (loss) values. This suggests priority binding of values that are higher in value, and also allows for an examination of salience effects, the positivity bias, and value-directed remembering accounts of how reward information is selectively processed and remembered by younger and older adults.

Experiment 1

In Experiment 1, younger and older adult participants studied a series of middle-aged faces that were paired with values ranging from 0 to $100 (see Figure 1 for examples). Participants were told that each face would be paired with a monetary value, and they should remember the values, but that the value indicated how much money the target person owed them. Thus, it was especially important to remember faces with higher values (although participants were not explicitly instructed to selectively attend to high-value face pairs). We were interested in whether both younger and older adults would selectively bind higher values with faces (displaying sensitivity to value), despite younger adults likely correctly recalling more of the associated values (consistent with the associative deficit hypothesis).

Method

Participants

The young adult participants were 32 University of California, Los Angeles, undergraduates (21 females, Mean age = 20.6) who participated for course credit. The older adult participants were 24 older adults recruited from the surrounding community (15 females, Mean age = 78.0), and were given monetary compensation for their time. The average reported education level of the older adults was approximately 16.4 years. The older adults were part of larger databased of participants who have undergone basic screening (e.g., digit span), prior to participating in the present study. All of the older participants reported that they were in good health, and did not report any prior relevant medical history that might influence cognition (e.g., stroke or dementia).

Materials

Twenty-eight faces were used from The Center for Vital Longevity Face Database (Minear & Park, 2004). All of the faces used were Caucasian, between the ages of 30 and 49 (to avoid an own-age bias for either the younger or older adults), and had a neutral expression on their face (i.e., not smiling or frowning). Half of the faces were female, and the other half were male. The 28 faces were randomly assigned to two study-test blocks - 14 during the first block and 14 during the second block. Within each block, two faces (one female and one male) were randomly paired with a value of 0, 1, 5, 10, 20, 50, or 100 dollars. The value were chosen to represent monetary amounts that were familiar (such as those on US bills), and to sample lower amounts as well as extreme higher amounts. Each photo was approximately 6 in x 5 in on the screen with the dollar value displayed directly above the photo in size 44 Arial font (see Figure 1 for an example). The order of face-value pairs during both the study and test phases of these blocks were presented in fixed random order (with four different versions), such that the order during study was different than the order during test.

Procedure

Participants were told they were going to study 14 faces for 10 s each, and that each face was paired with a dollar amount (see Figure 1). That amount was an indication of how much money that person owed the participant. If the value was $0, then that person did not owe the participant any money. Participants were instructed to remember as much information as they could, but specifically the amount that the person owed them. Participants were told the range of values that would be presented, and that the faces paired with $100 were worth the most. Participants were told that if they could correctly recall the value paired with that face, they would “get their money back”, and their goal was to collect as much money as possible. After studying each of the 14 faces, participants were immediately tested on how well they could remember the value paired with each face. Participants were told that while they would not receive actual money, they should still try to “collect” as much money as they could. Each of the 14 faces was shown to the participant one at a time, for 10 s each and the participant had to recall the value paired with each face. Participants were encouraged to guess if they could not remember the exact value. Participants gave their responses verbally and the experimenter recorded their responses. After the last face was tested, the experimenter added the correctly recalled values and informed the participants how much money they were “awarded.” No actual money was paid to participants aside from the compensation older adults received for participating. However, prior work has shown that this is an effective way to motivate both younger and older adults to achieve a high potential payout (Castel, Craik & Farb, 2007; Samanez-Larkin et al., 2007). It may be that the use of real monetary rewards and loss is more relevant to everyday life and results in even stronger behavioral effects. However, past research specifically on the use of monetary incentives in decision tasks involving gains and losses has generally not found significant performance differences due to the presence of real versus imagined monetary incentives (e.g., Grether & Plott, 1979; Lichtenstein & Slovic, 1979; see Read, 2005, for an in depth treatment. After receiving the feedback about the monetary amount they had achieved in the task, participants began a second study-test block with new faces paired with values.

Results and Discussion

We first examined the mean response (including both accurate and inaccurate responses) as function of the value associated with each face, and then the more precise recall accuracy (only considered corrected if participants recalled the exact value paired with the face). We were specifically interested in determining if the value associated with the faces influenced recall rates and, if so, in what manner recall performance was sensitive to the values. For that purpose, we conduct analyses using multilevel modeling (Raudenbush & Bryk, 2002), including values as a continuous variable (which is not possible in traditional ANOVA).

Mean Responses as a Function of Value

Figure 2A shows the mean response (the estimated value provided by the participant, as in some case these were inaccurate guesses) as a function of actual amount owed for both younger and older adults across both blocks. As participants completed two study-test lists with different faces, we examined any effect of block on recall. Neither the main effect of block nor the interaction involving block was statistically significant (*p*s > .09), as both groups showed similar effects in each block, so all results are collapsed across blocks. Overall, both age groups provided higher estimated values as actual owed values increased, suggesting that both groups showed good general sensitivity to the values, and provided higher values for faces that owed more money. Visual inspection of Figure 2A further indicates that younger adults provided better estimates than older adults, which is reflected in a steeper slope with regard to the relationship between actual values owed and estimated values.

To confirm this observation, we tested a multilevel model predicting estimated values from actual values owed (group-mean centered), age groups (dummy coded --- older adults were the reference group), and their interaction. Trials were treated as Level 1 units and participants were treated as Level 2 units. Random participant intercept and slope (of actual values owed) were estimated. The analysis produced a significant main effect of actual values owed ($\beta = 0.51$, $p < .01$), and more importantly a significant actual values X age group interaction ($\beta = 0.22$, $p < .01$). These results suggest that older adults showed overall sensitivity to the values in guessing owed money ($\beta = 0.51$), but the slope is even steeper for younger adults (β = 0.73). The main effect of age group was not statistically significant (β = −1.12, *ns*).

Overall Correct Recall as a Function of Value

We examined recall accuracy, only scoring a response as correct if the exact amount provided as a response matched the amount that was originally paired with the face (see Figure 2B). One interesting observation from Figure 2B is that the actual values owed appears to have a curvilinear relation with correct recall rate, with extreme values (i.e., $0 or $100) being better recalled than mid ranged values (Madan & Spetch, 2012).

Based on such observation, to understand the effect of amount of value and possible age-related differences in recall accuracy, we conducted multilevel modeling, predicting the correct recall rate from the linear and quadratic components of actual values owed, age groups, and their interactions. The actual values owed (0, 1, 5, 10, 20, 50, 100) are coded as −3, −2, −1, 0, 1, 2, and 3, respectively (because the dependent variable is not on the same metric as the independent variable in the current analysis, this coding is more appropriate). Again, trials were treated as Level 1 units and participants were treated as Level 2 units. Random participant intercept was estimated, but we fixed random participant slopes (both for linear and quadratic effects) to zero, because preliminary analyses showed that these random effect variances were not statistically significant.

The results showed a significant main effect of age groups (β = 0.16, $p < .01$), indicating that younger adults generally have more accurate responses than older adults. Interestingly, the linear effect of actual values owed was not statistically significant (β = 0.00, *ns*), but instead, consistent with the observation, the quadratic effect of actual values owed was statistically significant (β = 0.03, $p < .01$). Neither linear nor quadratic effects interacted with age groups. We provide the fitted quadratic curves for both younger and older adults in Figure 2B. Thus, it appears that both younger and older adults' memory performance was sensitive to extreme values, and not simply influenced by better memory for higher values.

Summary

The present experiment showed that both younger and older adults' memory was sensitive to the values associated with faces, such that both groups provided higher values for faces paired with greater amounts owed. While age differences were present for the higher value faces, as well as the lower value faces, both groups were sensitive to the extreme values, and performed well for the lowest and highest values.

Experiment 2

In Experiment 2, we sought to replicate and extend the main findings from Experiment 1, and to determine if younger and older adults may differentially remember associated values that were associated with gains as well as losses. In Experiment 2, participants studied faces paired with values ranging from $-100 to $100. Faces paired with negative values were people who the participant owed money to, whereas faces paired with positive values were faces that owed them money. We hypothesized that, compared to Experiment 1, with a greater range in face-value pairs to encode, younger and (perhaps especially) older adults may be more selective about what face-value pairs they attempt to remember. Although some prior work has shown less sensitivity to losses in older adults (e.g., Samanez-Larkin et al., 2007), there have also been findings in the opposite direction (greater loss sensitivity in older adults), as well as null findings (see Eppinger et al. 2011 for a review). Thus, we were interested in whether older adults, relative to younger adults, might show poorer cue-recall performance for the faces associated with negative (debt) values, and this might be predicted by a positivity bias or selective processing due to not being able to remember all of the presented face-value pairings.

Method

Participants

The young adult participants were 24 University of California, Los Angeles, undergraduates (19 females, Mean age = 20.0) who participated for course credit. The older adult participants were 24 older adults recruited from the surrounding community (14 females, Mean age = 78.5), and were given monetary compensation for their time. The average reported education level of the older adults was approximately 15.6 years. All of the older participants reported that they were in good health.

Materials

The materials were identical to that of Experiment 1, with some exceptions. The values paired with each face were changed such that negative values were included with each study-test block. The values used for Experiment 2 were: −100, −50, −20, −10, −5, −2, −1, 1, 2, 5, 10, 20, 50, and 100 dollars. The 0 value used in Experiment 1 was omitted for Experiment 2. On each of the two blocks, one face was paired with each associated value (whereas in Experiment 1 two faces were paired with each associated value). During study, positive values were shown in green font and accompanied by a "+" sign, while negative values were shown in red font and accompanied by a "−" sign. Sample stimuli are shown in Figure 1B, and the color and sign were used so that people didn't confuse the value and gain/loss information during the encoding session.

Procedure

The procedure used was similar to that of Experiment 1, with some exceptions. Before the first study-test block, the participants were told that they would owe some of the faces shown a given amount, while other faces shown would owe them a given amount. If they could successfully recall the amount owed to them, they would be "awarded" that value at test. Additionally, if they could successfully recall the amount they owed to specific faces, they would not have to pay back that amount. That is, if the participant failed to correctly recall the amount they owed to the negative value faces, they would be "penalized" that amount. During the test phase of each of the two blocks, the participant had to respond with whether they owed that person or the person owed them money, in addition to what the specific amount owed was. For positive values, if the participant correctly recalled the amount, they were awarded that value on their total. For negative values, if the participant failed to correctly recall the amount, they were penalized that value on their total. These penalizations made it possible for someone to receive a negative total, meaning they would "owe" that amount (as in Experiment 1, however no money was paid to or taken from participants). The experimenter then gave the participant feedback on the amount to be awarded or paid. As in Experiment 1, participants repeated the task on the second study-test block (with new faces and values).

Results and Discussion

We examined the mean estimated response (grouping both accurate and inaccurate responses) as function of the value associated with each face, the recall accuracy (only considered correct if participants recalled the exact value paired with the face), as well as the overall trends of the accuracy rates as a function of the values associated with faces. As the current experiment also included negative values, we were specifically interested in determining if the type (gain versus loss) or the magnitude of the value associated with the faces influenced recall rates, and if participants recall performance was sensitive to the potential gains and losses associated with values. Again, to make full use of the information from the data, we conduct analyses using multilevel modeling (Raudenbush & Bryk, 2002).

Mean Responses as a Function of Value

Figure 3A displays the estimated value owed as a function of actual amount owed for both younger and older adults across both blocks. In this experiment, for the purpose of presentation, we binned some of the owed values but all of the analyses were conducted without binning the values. As in Experiment 1, both age groups provided higher estimated values as the magnitude of values increased, suggesting that both age groups were sensitive to the amount in question. Visual inspection of Figure 3A indicates that the weaker interaction may be driven by the fact that the slopes for younger and older adults do not differ in the gain region but differ in the loss region, suggesting that older adults underestimated the magnitude of the values associated with losses.

We conducted multilevel modeling, analogous to what was done in Experiment 1, separately for gain and loss regions. In the gain region, analysis showed a significant effect of actual value ($\beta = 0.35$, $p < .01$) and this effect did not interact with age group ($\beta = 0.08$, *ns*), indicating that both younger adults ($\beta = 0.43$, $p < .01$) and older adults ($\beta = 0.35$, $p < .01$) were sensitive to actual value. These findings are consistent with Experiment 1. The main effect of age group was not statistically significant ($\beta = -3.59$, *ns*). In the loss region, on the other hand, the analysis showed a marginally significant main effect of actual value ($\beta = 0.18$, $p = .069$), and a trend for an effect of actual value x age group interaction emerged ($\beta = 0.27$, $p = .056$). These results indicate that older adults have weak sensitivity to actual value in loss region ($\beta = 0.18$, $p = .069$) but this sensitivity is stronger for younger adults ($\beta = 0.45$, $p < .01$). The main effect of age group was not statistically significant ($\beta = -2.14$, *ns*).

This asymmetry between gain region and loss region is clearly illustrated in the extreme values: in the loss region, there was a trend such that the extreme value ($100) was better calibrated by younger adults, $t(43) = 2.01$, $p = .05$. However, in the gain region, the calibration of the extreme value ($100) was not statistically different between younger and older adults, $t(44) = .49$.

Overall Correct Recall as a Function of Value

We examined recall accuracy, scoring a response as correct only if the exact amount and type (the participant owed the money or the money was owed to them) provided as a response matched what was originally paired with the face. These results are presented in Figure 3B. The curvilinear relationship between the actual values and correct recall rate found in Experiment 1 appears evident in Experiment 2 for both the gains and losses in younger and older adults (Figure 2B).

We conducted multilevel modeling, analogous to what was done in Experiment 1 (i.e., multilevel regression analysis with a quadratic term). We conducted a separate analysis for the gain and loss regions. In the gain region, the main effect of age group was statistically significant ($\beta = 0.13$, $p < .01$), indicating that younger adults generally exhibited better recall. The main effects of both linear and quadratic slopes were also statistically significant ($\beta = 0.04$ and 0.02, respectively, $ps < .05$), confirming the curvilinear relationship between actual value and correct recall observed in Figure 2B. No significant interactions of age group were observed. In the loss region (we used the absolute value of actual money to facilitate interpretation of regression coefficients), main effect of age group was statistically significant ($\beta = 0.14$, $p < .01$), indicating that younger adults generally exhibited better recall. The linear slope effect was not statistically significant ($\beta = 0.00$, *ns*) but, importantly, this linear effect interacted with age group ($\beta = 0.04$, $p < .05$). This indicates that, whereas older adults are not sensitive to the increasing monetary value in the loss region ($\beta = 0.00$, *ns*), younger adults are ($\beta = 0.04$, $p < .01$). Indeed, a significant age group difference was observed in the extreme values of the loss region, $t(46) = 2.22$, $p < .05$, whereas the extreme values in the gain region did not show significant age differences, $t(46) = 0.81$, $p = .42$.

Main effect of quadratic slope was statistically significant ($\beta = 0.02$, $p < .01$), again confirming the curvilinear relations between actual value and correct recall performance. This quadratic effect was not interacted with age group ($\beta = -0.00$, *ns*). The fitted quadratic curves for both younger and older adults are plotted in Figure 3B.

Summary

In Experiment 2, participants studied faces paired with values ranging from $-100 to $100, to further examine the effects of value, and to extend this to gains and losses. While both age groups were sensitive to value, older adults were more sensitive to gains versus losses, and this might reflect strategic (and biased) processing of positive values among older adults. Similar to Experiment 1's findings, both age groups showed stronger memory for extreme values. This was present for both gains and losses, suggesting that the saliency effects of these extreme values may influence associative memory for both age groups.

General Discussion

In two experiments, we examine how value influences associative memory performance in younger and older adults. When studying faces paired with monetary values that represented how much money the person owed the participant, younger and older adults were sensitive to value, such that both age groups were more likely to accurately remember higher (vs.

lower) values associated with faces, relative to the middle amounts, and younger adults typically remember more of the values overall. In both experiments, younger and older adults also recalled the extreme lower values more than the mid-range values, though higher values were recalled most frequently. In Experiment 2, where negative values were also associated with faces, older (but not younger) adults were less likely to recall these values correctly. This is a novel finding regarding how aging may lead to biases when processing negative versus positive monetary values. Together, the results of Experiments 1 and 2 shed light on how associative memory is influenced by value as well as how gains and losses may be differentially processed by younger and older adults.

The value-directed remembering framework suggests that younger and older adults use value to guide memory processes, leading to better memory for higher value information. More specifically, some free recall tests of episodic memory show that age-related differences are reduced or eliminated for the recall of high-value information (e.g., Castel et al., 2002; Hayes et al., 2013). The present research did not find direct support for the assertion that age-related differences would be reduced for high-value information. While both groups were sensitive to value, age-related differences were present for high-value information. This may be a result of the associative nature of the value task, in that participants had to bind the value to the face and successfully recall this precise value later when presented with the target face. The presence of an associative memory deficit among older adults (Naveh-Benjamin, 2000) may prevent this binding from occurring, leading to age-related differences for recalling the specific item (the correct value) when seeing a certain target face. However, both age groups were sensitive to the values insofar as both groups recalled higher values for faces originally paired with higher values, suggesting perhaps that gist-based retention of value is maintained (or is relied on) in older adults (cf., Tun, Wingfield, Rosen & Blanchard, 1998; Reyna & Brainerd, 1992; Reder, Wible & Martin, 1986). Additionally, some support was found for the “salience” hypothesis (Madan & Spetch, 2012), as the effects of value on memory were often quadratic in nature, with better memory for the extreme values relative to the middle values. The present work extends these salience-based effects to older adults, although it remains unclear if these salience effects are based on strategic processing or more automatic processes for both age groups. We do note that the extreme/highest values (e.g., $100) may be processed as distinct relative to the larger number of lower values (ranging from $1 to $50), and this may lead to selective attention to these high values. Thus, the composition of lower and high value pairings may be something that leads to salience, and can guide attention and the strategic encoding of high-value associations.

The present investigation shows that value can guide how younger and older adults bind information. Prior work with younger adults has shown that point values associated with faces can also influences memory for names (Festini et al., 2013), though this has not been examined in older adults. The present work suggests that older adults can use value to guide associative memory, and that value might also bias what older adults remember. Experiment 2’s finding that older adults showed a stronger value effect for positive versus negative amounts of money might suggest a monetary-based “positivity effect” in that older adults selectively focus on the money owed to them (potential gains), rather than the money they owe (potential losses). In other contexts, prior work has shown less sensitivity to losses in older adults (Samanez-Larkin et al., 2007), though this literature is mixed in that some work has found the opposite, or null age-related effects (Eppinger et al., 2011). The present study provides a useful extension of prior work by examining associative memory for potential gains and losses, something that has important consequences for older adults, who often express concern over declines in associative memory (such as remembering names and faces).

The present findings are consistent with the positivity effect for emotional information (Mather & Carstensen, 2005), in that older adults are more likely to remember positive emotional information relative to negative emotion information. In addition, older adults will avoid negative emotional information. The current results extend the notion of a positivity bias to situations that involve monetary value, and memory for potential gains versus losses, and could have important implications for how older adults process and retain important financial information regarding gains and losses (cf., Mata et al., 2011; Samanez-Larkin et al., 2011). Consistent with socioemotional selecitivity theory (Carstensen, 1992), older adults may avoid processes loss information because owing money could be thought of as aversive, and the positivity bias guides them toward focusing on regulating and enhancing mood by focusing on gain information.

In summary, the present findings suggest that while age-related differences exist in terms of overall recall, younger and older adults both show strong sensitivity to value, and older adults may focus on gains and losses in a different manner, in order to guide associative memory processes, and this could potentially influence social behavior and financial decisions. Older adults may tend to selectively remember people who are associated with positive outcomes (possibly to enhance mood), or information that is linked to gains, relative to focusing on loss information, such as when choosing insurance plans and investment portfolios. The present research outlines some important age-related similarities and differences when remembering gains and losses, but there are likely a number of inter-related social, motivational, cognitive, and economic factors that can contribute to when, how, and why people remember gains relative to losses. Indeed, socioemotional selectivity theory explicitly considers the role of multiple social, motivational, and cognitive factors in age-differences in goal-directed behaviors. Future research is needed to more clearly determine more mechanistic accounts, and develop applications, that could inform broader decisions regarding public policy for a growing older population.

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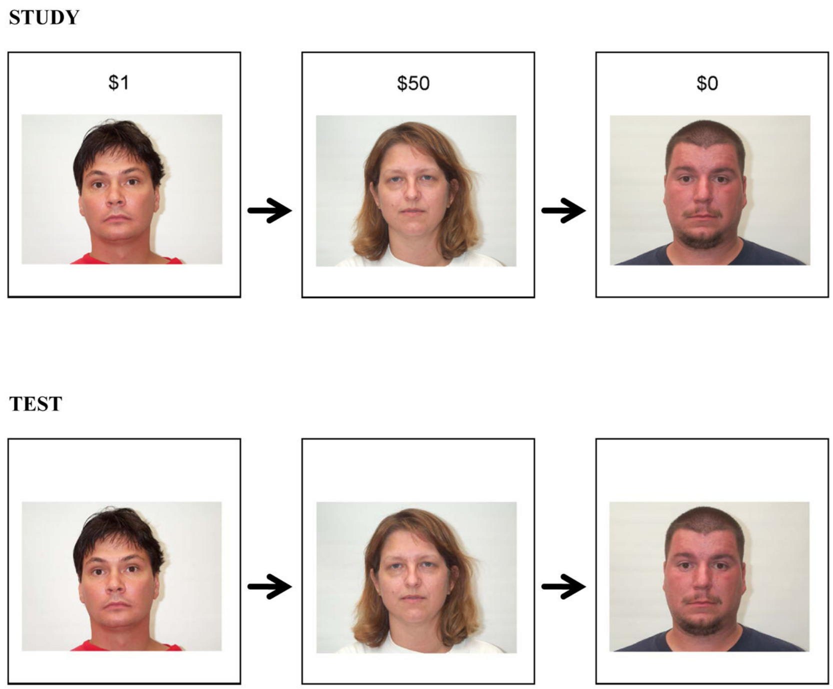

Figure 1A

Figure 1a

Figure 1B

Figure 1b

Figure 1.

A sample trial sequence during the study phase (top panel) and test phase (bottom panel) in Experiment 1. Each face was presented for 10 seconds.

Figure 1A: A sample trial sequence during the study phase (top panel) and test phase (bottom panel) in Experiment 1. Each face was presented for 10 seconds.

Figure 1B: A sample trial sequence during the study phase (top panel) and test phase (bottom panel) in Experiment 2. Each face was presented for 10 seconds, and the procedure was similar to that of Experiment 1, but gains (money owed to you by the depicted face) were presented in green, with the dollar amount preceded by a positive (+) sign, while losses (money that you owed to the depicted face) were presented in red, with the dollar amount preceded by a negative (−) sign.

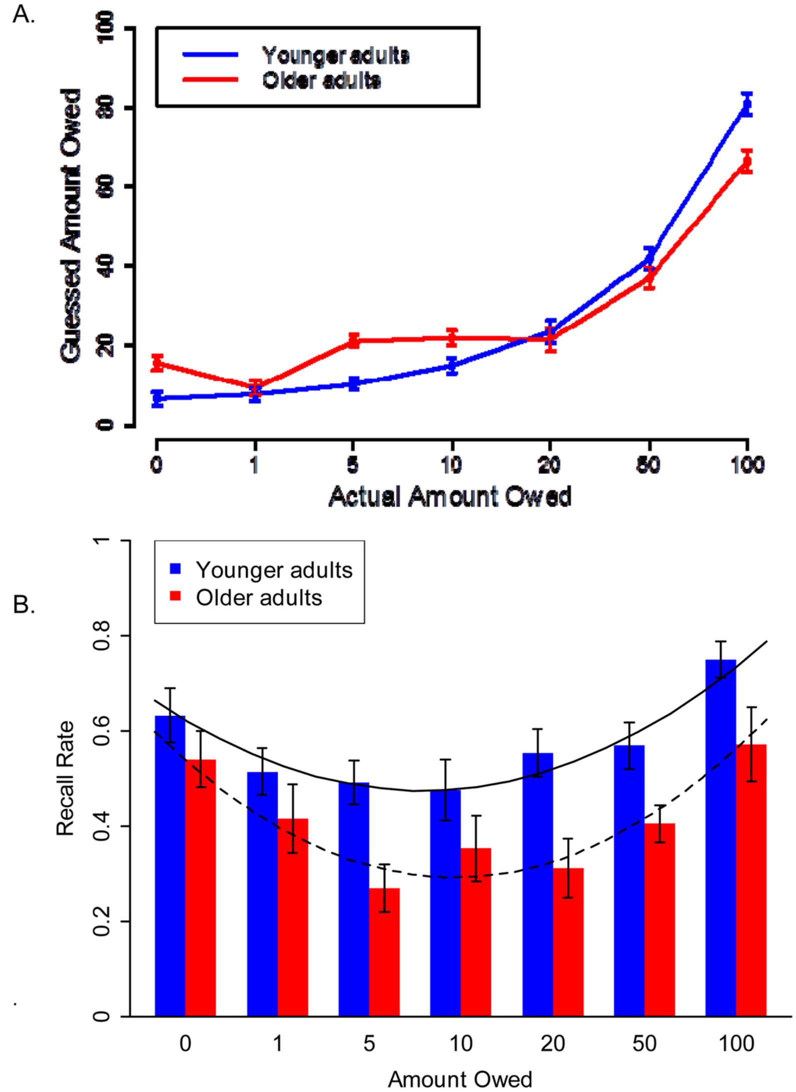

Figure 2.

Figure 2A: The mean estimated value owed (including both accurate and inaccurate responses) as a function of the actual amount owed for younger and older adults in Experiment 1. Error bars represent standard error of the mean.

Figure 2B: Mean proportion correct recall of monetary value associated with each face in Experiment 1. Error bars represent standard error of the mean. The significant quadratic trend analyses are also presented as a solid line for younger adults and dotted line for older adults.

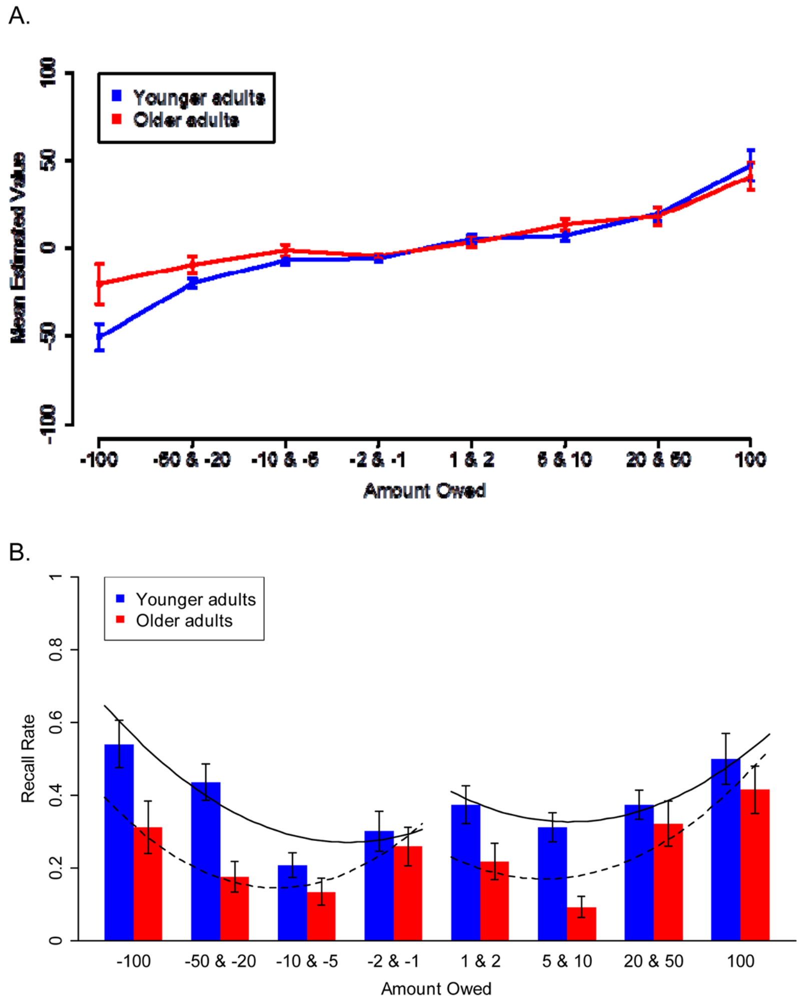

Figure 3.

Figure 3A: The mean estimated value owed (including both accurate and inaccurate responses) as a function of the actual amount owed for younger and older adults in Experiment 2. Error bars represent standard error of the mean.

Figure 3B: Mean proportion correct recall of negative and positive monetary value associated with each face in Experiment 2. Error bars represent standard error of the mean. The two significant quadratic trend analyses (plotted separately for negative and positive values) are presented as a solid line for younger adults and dotted line for older adults.