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Affect Dynamics, Affective Forecasting, and Aging

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Affective forecasting, experienced affect, and recalled affect were compared in younger and older adults during a task in which participants worked to win and avoid losing small monetary sums. Dynamic changes in affect were measured along valence and arousal dimensions, with probes during both anticipatory and consummatory task phases. Older and younger adults displayed distinct patterns of affect dynamics. Younger adults reported increased negative arousal during loss anticipation and positive arousal during gain anticipation. In contrast, older adults reported increased positive arousal during gain anticipation but showed no increase in negative arousal on trials involving loss anticipation. Additionally, younger adults reported large increases in valence after avoiding an anticipated loss, but older adults did not. Younger, but not older, adults exhibited forecasting errors on the arousal dimension, underestimating increases in arousal during anticipation of gains and losses and overestimating increases in arousal in response to gain outcomes. Overall, the findings are consistent with a growing literature suggesting that older people experience less negative emotion than their younger counterparts and further suggest that they may better predict dynamic changes in affect.

Keywords: aging, emotion experience, affective forecasting, reward processing, decision making

Particularly in the context of health care or financial decisions, older people regularly make implicit predictions about their future preferences, physical and cognitive abilities, and emotional states. Discussions about preferences for future care, for example, between physicians and patients or among family members, and formal documents like advance directives, depend on the assumption that these predictions are sound. Because some of these decisions can have life-or-death consequences, the validity of such assumptions is of crucial importance. Yet recent studies of affective forecasting—which have focused mostly on college student populations—have suggested that people make reliable errors when predicting future emotional states (see Wilson & Gilbert, 2003, for a review) and that forecasting errors can lead to suboptimal decisions (Gilbert & Ebert, 2002).

People also make errors when asked to recall the duration and intensity of their affective experiences (Fredrickson & Kahneman, 1993; Robinson & Clore, 2002). Robinson and Clore (2002) argued that errors in recall arise because memories for the affective qualities of the original experiences rapidly fade, resulting in an overreliance on folk theories about what kinds of experiences are pleasant versus unpleasant (or arousing vs. nonarousing) when generating recollections. These kinds of "hot–cold empathy gaps" (Loewenstein & Schkade, 1999) may contribute to failures in properly predicting or recalling affective responses to decision outcomes, resulting in inaccurate inputs to decision-making processes.

It is not known whether older adults share these deficits or if forecasting and recall errors hold when people consider issues of great personal relevance. Understanding how affective experience and prediction change over the life span may have important implications for understanding decision making at different life stages.

The present study specifically focuses on the prediction, actual experience, and recollection of affective states elicited during the anticipation and realization of positive and negative monetary outcomes. Our aims in this research were (a) to compare and contrast patterns of dynamic changes in affect associated with monetary incentives in younger and older adults, (b) to compare and contrast younger and older adults' ability to predict and recollect these affective changes, and (c) to explore whether parsing affective responses into anticipatory and consummatory phases and along arousal and valence dimensions would shed light on previously documented errors in affective forecasting.

As individuals age, declines in working memory, attention, and some executive abilities may tax the cognitive capacity necessary for decision making. At the same time, improvements in other domains such as increased world knowledge (Park et al., 2002) and better ability to regulate emotional states (Carstensen & Charles, 1998) and solve emotionally charged problems (Blanchard-Fields, Janke, & Camp, 1995) may facilitate decision making. Recent findings have revealed that older adults show relatively less neural activation and subjective recall of affective experiences during loss anticipation (Samanez-Larkin et al., 2007). However, whether age differences in anticipatory affect have a differential impact on

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older and younger adults' experience of outcomes, affective forecasting, and affective recall is unknown. We hypothesize that an increased focus on socioemotional concerns may influence how older adults react to emotionally salient events and subsequent decision making.

According to socioemotional selectivity theory, the temporal frames that people hold—which vary reliably with chronological age (Carstensen, Isaacowitz, & Charles, 1999)—influence people's goals. Younger adults typically have an expansive time perspective and a future orientation and possess goals related to information gathering and preparation for future challenges. Older adults typically perceive more limited time horizons, promoting an emphasis on emotionally meaningful goals and close personal relationships. As a result of this shift, older adults tend to focus on the present, favor positive information, and strive for emotional equilibrium. There is a growing body of evidence supporting a positivity effect in memory and attention, whereby older adults devote relatively more cognitive resources to positive as compared with negative emotional information (see Carstensen, 2006, and Mather & Carstensen, 2005, for reviews). This effect can be contrasted with the negativity bias typical of younger adults, whereby negative material gains priority for processing, probably because of its information value in planning for the future (Cacioppo & Gardner, 1999). Yet little is known about the relationship between the positivity effect and older adults' affective forecasting. It is possible, in light of findings about the positivity effect, that older adults anticipate positive outcomes or deemphasize negative outcomes as a way of maintaining emotional stability. If so, such tendencies could make older people especially likely to fall prey to sales pitches that promise significant rewards and perhaps have overly optimistic expectations about decision outcomes in general.

The temporal frames people hold could influence choices either by prioritizing current emotional states or by emphasizing particular kinds of future outcomes. One hypothesis is that accumulated emotional experience combined with heightened attention to emotion in the service of emotional regulatory goals will make older adults more accurate at recalling and predicting the dynamic changes in their affective states. Alternatively, older adults may paint the past (and possibly also the future) in an especially positive light to maintain emotional equilibrium in the present, leading to errors in forecasting and recall.

In the present study, using affective probes, we measured the dynamic movement along valence and arousal dimensions in younger and older adults as they were engaged in a monetary incentive delay (MID) task (Knutson, Adams, Fong, & Hommer, 2001), a fast-paced video game in which participants work to gain and avoid losing various amounts of money. We compared age groups on measures of forecasted, experienced, and recalled affect. We explored whether separate consideration of the unique affective properties of anticipatory and consummatory phases of past or future events or separate consideration of changes in affect along both arousal and valence dimensions would most precisely identify the source of previously described errors in affective forecasting and affective recollection. We used a procedure we call the "affect probe" method, which involves sampling affect on separate dimensions during different repeatable task phases as participants are actively engaged in a task.

In preliminary research using the affect probe method (Knutson, Nielsen, Larkin, & Carstensen, submitted for publication), we found that younger adults reported dynamic change in both valence and arousal during anticipation of incentives in the MID task, while during outcomes dynamic change in affect was confined primarily to the valence dimension (see also Cooper & Knutson, 2008). However, when younger adults were asked to forecast their affect on the MID task in terms of both valence and arousal dimensions during anticipatory and consummatory phases, forecasting errors were confined to the arousal dimension only, with respect to both the anticipation and the experience of gain trial outcomes.

On the basis of these behavioral findings, on recent neural evidence of age differences in insula and medial caudate activation during anticipation of losses, and on research showing a positivity effect in attention and memory of older adults, we predicted that (a) younger adults would experience stronger negative arousal during anticipation of losses compared with older adults, but would not differ from older adults in their experiences of positive arousal during gain anticipation; (b) because older adults would not experience strong negative arousal during loss anticipation, they would show less of a positive response to loss avoidance than younger adults; and (c) age differences in anticipatory and outcome-elicited affect would emerge on the valence but not the arousal dimension and for outcomes would be specific to unexpected outcomes (avoiding losses and missing gains), which have been associated with shifts in valence ratings in prior research (Mellers, 2000; Mellers & McGraw, 2001).

Next, we predicted that younger adults would show affective forecasting errors on the arousal but not the valence dimension and explored whether they would correct these errors during subsequent recall of affective experience. Finally, we tested two competing hypotheses regarding age differences in affective forecasting and recall. The first predicts that older adults would be more accurate than younger adults in forecasting and recalling their affective experiences in the MID task because of heightened attention to socioemotional concerns. The second predicts a positivity bias in older adults' affective forecasts and recall, consistent with the positivity effect documented in older adults' attention and memory for emotional information.

Method

Participants

Participants were recruited by a survey research firm and asked to participate in three laboratory sessions examining emotional reactions to winning and losing. All participants reported their physical health as average or better than average for their age and had no history of neurological or psychiatric illness or substance abuse. Informed consent was obtained in accordance with National Institutes of Health guidelines for human participants research. Participants received $50.00 for each of three laboratory sessions and any winnings obtained while playing the MID task (M = $101.35, SD = $55.51).

Twenty younger adults ages 20–35 years ($M = 25.5$, $SD = 4.8$) and 20 older adults ages 65–85 years ($M = 74.3$, $SD = 7.3$) from the San Francisco Bay area participated. Each group included equal numbers of men (6 Caucasian American and 3 African

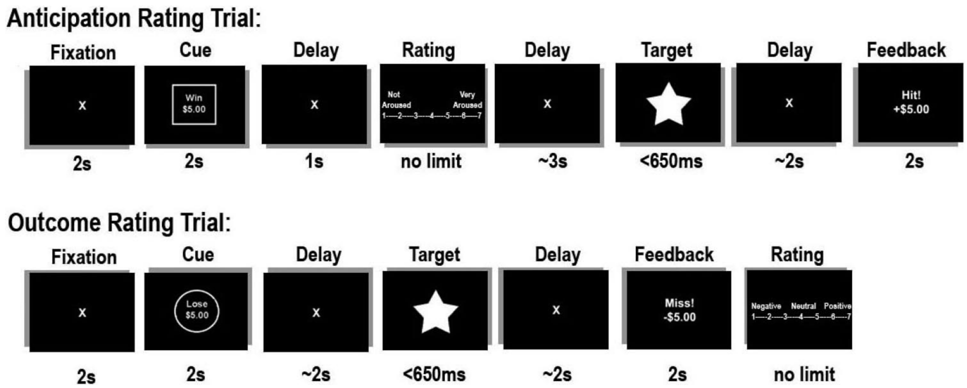

Figure 1. Monetary incentive delay task schematic. Timing of stimulus and response intervals for anticipation rating trial (upper panel) and outcome rating trials (lower panel) is shown. In all trials, participants saw a cue (Cue, 2,000 ms), were instructed to focus on a fixation cross while waiting for a variable anticipatory delay period, responded with a button press to a solid white star (Target, <650 ms), fixated on a cross (Fixation, ~2,000 ms), received feedback (Feedback, 2,000 ms), and focused again on a fixation cross (Fixation, 2,000 ms). In anticipatory rating trials, valence or arousal ratings were elicited after seeing the cue but before responding to the target. In outcome rating trials, valence or arousal ratings were elicited immediately after receiving outcome feedback.

American) and women (7 Caucasian American and 4 African American), and groups were matched for scaled income and education level (ranging from high school/trade to college/advanced).

Groups differed on measures of cognitive ability, with younger adults outperforming older adults on two measures of fluid intelligence, the Digit Symbol subtest of the revised Wechsler Adult Intelligence Scale, $t(35) = 4.68$, $p < .001$ (data missing from 1 younger and 2 older participants because of testing errors) and the Reading Span task (Daneman & Carpenter, 1980), $t(38) = 2.43$, $p < .05$. In contrast, older adults scored significantly higher than younger adults on the Nelson-Denny Vocabulary test (Nelson & Denny, 1960), a measure of crystallized intelligence or world knowledge, $t(38) = 2.22$, $p < .05$. Imputed years of formal education was positively correlated with vocabulary score ($r = .597$, $p < .001$).

On a measure of future time perspective (Carstensen & Lang, 1996), the extent to which individuals view the future as constrained, younger participants reported a greater overall future-oriented outlook than older adults, $F(1, 36) = 41.33$, $p < .001$, $\eta^2 = .53$, reflected in subscales measuring both time perspective, $F(1, 36) = 26.29$, $p < .001$, $\eta^2 = .22$, and future goal orientation, $F(1, 36) = 43.51$, $p < .001$, $\eta^2 = .55$. Chronological age was negatively correlated with overall future orientation ($r = -.72$, $p < .001$), time perspective ($r = -.68$, $p < .001$), and goal orientation ($r = -.68$, $p < .001$). There were no age differences in self-reported physical health as measured by the Wahler Physical Symptoms Inventory (Wahler, 1973). As is typically found, younger adults reported more depressive symptoms on average than older adults as measured by the Center for Epidemiologic Studies Depression Scale (Radloff, 1977), $F(1, 36) = 4.41$, $p < .05$, $\eta^2 = .11$ (younger adults, $M = 13.16$, $SD = 2.94$; older adults, $M = 8.27$, $SD = 1.85$).

MID Task and Probes

The MID task is a computer-based speeded reaction time task in which participants must respond quickly to cued targets to gain or avoid losing money. During each MID task trial, participants view one of six different cues (circles/squares) displaying the amount of money that could be gained or lost on that trial (anticipation phase). If the participant responds quickly enough to a subsequent target (star), he or she either gains or avoids losing money (outcome phase).

A canonical version of the MID task (Knutson, Fong, Bennett, Adams, & Hommer, 2003) was modified in the following ways (see Figure 1). First, the display duration of each cue was lengthened to 2 s to accommodate differences in vision and reading time among younger and older participants. Second, the traditionally used abstract symbolic cues (circles and squares) were replaced with literal symbolic cues representing the six trial types (win $0.00, win $0.50, win $5.00, lose $0.00, lose $0.50, and lose $5.00) that explicitly stated whether the trial was a potential gain or loss trial and the amount of money at stake. Third, subjective ratings of affect were solicited during either the anticipation or the outcome phase of each trial, resulting in two different trial structures (described below). Seven-point Likert scales were used to index either valence (1 = *very negative,* 4 = *neutral,* and 7 = *very positive*) or arousal (1 = *not at all aroused* and 7 = *very aroused*).

Participants rated anticipatory valence or arousal and outcome valence or arousal in four separate counterbalanced blocks. Each block contained 18 trials and began with a starting value of $0.00. Within each block, each of the six trial types was pseudorandomly ordered and presented three times—one difficult, one moderately difficult, and one easy—as determined by target duration (see below). Cumulative earnings were paid out in cash at the end of the experiment. Net losses resulted in no payment but were not deducted from the participation fee.

Trial structure. All trials began with a fixation cross (2,000 ms), followed by a cue (2,000 ms) indicating the amount of money at stake. During anticipation rating trials, cues were followed by a fixation cross (anticipation, 1,000 ms), followed by either the valence or the arousal scale, which remained on the screen until the participant responded (unlimited duration). A fixation cross then appeared (±3,000 ms), followed by a target (<650 ms, individually adjusted as described below), which required a response, followed by a fixation cross (±2,000 ms), followed by feedback showing the participant's current earnings (outcome; 2,000 ms). During the outcome rating trials, the cue was followed by a fixation cross (anticipation, ±2,000 ms), followed by a briefly presented target to which the participant had to respond (target, <650 ms), followed by a fixation cross (±2,000 ms), followed by feedback showing the participant's current earnings (outcome, 2,000 ms), followed by either the valence or the arousal scale that remained on the screen until the participant responded (unlimited duration). Pre- and posttarget delay durations were adjusted using an algorithm that subtracted target duration time at random from either delay, while keeping total delay + target + delay time constant (i.e., 4 s) across trials within a block.

Target duration. Three levels of trial difficulty were individually adjusted to yield approximately 66% hit rates for each trial type. Each individual's mean reaction time (MRT) was calibrated in a preexperiment button press task. Hard target duration was set to MRT − 100 ms; medium target duration was set to MRT, and easy target duration to MRT + 100 ms.[1] Thus, blocks were constructed to yield both hits and misses for each trial type and to result in positive cumulative balances and maximize participant engagement. MRTs differed significantly by age group, $t(38) = 4.1$, $p < .001$ (younger adult, mean RT = 255 ms, $SD = 56$, range = 170–398 ms; older adult, mean RT = 332, $SD = 62$, range = 245–549 ms).

Procedure

Experimental sessions took place in the Life-Span Development Laboratory in the Psychology Department of Stanford University. At the beginning of the session, participants received detailed instructions about the contingencies of the MID task and use of the valence and arousal scales. They then completed a paper-and-pencil affective forecasting survey asking them to imagine playing the MID task and to predict their experience of valence and arousal when anticipating gaining or losing or actually gaining or losing $0.00, $0.50, and $5.00. Participants were then trained on the computerized MID task and played a version of the task without affect probes while facial electromyographic and skin conductance responses were recorded (results reported elsewhere).[2] Immediately following this task, participants played the MID task while providing online affect ratings as described above.

At the end of the session, participants completed a retrospective questionnaire in which they recalled their feelings of valence and arousal when anticipating gaining or losing or actually gaining or losing $0.00, $0.50, and $5.00 in the MID task. Additionally, 1 week later, participants were mailed a second copy of the retrospective questionnaire to complete and return by mail. After playing the MID task, participants completed personality, health, and cognitive assessments.

Data Analysis

Participants provided three valence and arousal ratings at anticipation and between zero and three ratings at outcome for each condition, depending on performance. Change scores were computed for ratings to capture dynamic changes in affect during the task. Data were collapsed across all difficulty levels (easy, medium, and hard) for each trial type when calculating affect change scores. Anticipation change scores were calculated independently for the valence and arousal dimensions, with reference to a non-incentive task-specific reference point. This reference point was defined (separately for valence and arousal) as the mean of all anticipatory and outcome ratings for $0.00 trials, an indication of affective experience during the task when nothing is at stake and nothing is gained or lost. Thus, for example, anticipatory valence change in response to cues indicating potential $5.00 gains was calculated as the participant's mean valence rating during the $5.00 anticipatory phase, minus his or her valence reference point. Outcome change scores were calculated with reference to raw anticipatory ratings for each incentive condition (e.g., the participant's mean raw valence rating for gain outcomes of $5.00 minus his or her mean raw valence rating for anticipating a $5.00 gain). These change scores index the amount of movement along the arousal or valence dimension during particular task phases rather than just the raw level of reported valence or arousal, thus capturing movement through affect space across time.

For each task phase (anticipation, hit outcome, and miss outcome), mean rating change scores were submitted to repeated measures analyses of variance (ANOVAs) to determine the effects of incentive and magnitude on valence and arousal change. In these analyses, the between-subjects factor was age group (younger or older) and the within-subject factors were incentive (gain or loss) and magnitude ($0.50 or $5.00). Because participants performed well (more hits and fewer misses overall), outcome analyses were constrained to $5.00 incentives to provide sufficient numbers of participants with observations for each condition. All analyses controlled for baseline valence or arousal, using the reference point values described earlier. Greenhouse-Geisser corrections on degrees of freedom were used in cases of violations of the sphericity assumption. Within-subjects comparisons were made on rating change scores with Bonferroni-corrected pairwise comparisons.

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[1] Reaction times improved on the MID task, relative to the practice task, thus participants were expected to miss on hard trials and hit on medium and easy trials. Because the task was structured with separate blocks for each type of rating (anticipatory arousal, anticipatory valence, etc.) with only 18 trials in each block, it was not possible to develop an algorithm to adapt target duration to participant performance (as in our recent functional MRI task, Samanez-Larkin et al., 2007) and ensure that participants experienced an easy, medium, and hard trial of each type in each block. Instead, we adopted a procedure validated in earlier versions of the MID task (see Knutson et al., 2003), increasing to 100 ms the difference in target duration between medium and either easy or hard trials (enabling us to achieve equivalent hit rates in older and younger participants).

[2] Participants in this study also played the MID task on two additional occasions: once for the benefit of a participant-designated close friend and once when winnings accrued to another, unidentified, study participant. Patterns of affect dynamics were consistent across all three sessions for older and younger adults. Affective forecasting and recall were not assessed in these additional conditions. Because of the consistency of findings and space limitations, only data from the session in which participants earned money for themselves are reported here.

Results

Task Performance

Average hit rates were approximately 66% across trials (see Table 1). Hit rates were normally distributed and showed no significant group differences overall (for all trials, gain trials, or loss trials) or by specific trial type (win \$0.00, win \$0.50, win \$5.00, lose \$0.00, lose \$0.50, and lose \$5.00). Although there was considerable variability in both groups in overall earnings, average total earnings were normally distributed and did not differ significantly between groups, $t(38) = -1.011$, $p = .32$ (younger adults, M = \$30.23, SD = \$26.41; older adults, M = \$37.18, SD = \$15.73). Neither winnings nor hit rates (overall or by trial type) were correlated with age, education, income level, future time perspective, or any of our measures of cognitive function.

Univariate ANOVAs revealed that reference points for task-specific baseline valence and arousal did not vary significantly as a function of age group (see Table 2).

Affect Dynamics During the MID Task

Anticipatory Dynamics

With respect to anticipatory affect dynamics, we hypothesized that younger adults would show greater responses than older adults during loss anticipation on the valence dimension, but that they would not differ from older adults on the arousal dimension. Relevant analyses are described below.

Valence. We analyzed valence change during the anticipatory phase using a 2 (age group: younger or older) × 2 (incentive: loss or gain) × 2 (magnitude: \$0.50 or \$5.00) ANOVA, controlling for baseline valence. As predicted, older adults reported significantly less valence change in response to loss incentives than did younger adults, as revealed by a significant Age × Incentive interaction, $F(1, 37) = 25.52$, $p < .001$, $\eta^2 = .41$, qualified by an Age × Incentive × Magnitude interaction, $F(1, 37) = 7.33$, $p < .01$, $\eta^2 = .17$. Younger adults reported experiencing larger decreases in valence (movement in the negative direction) when anticipating large losses than small losses ($p < .01$) and larger increases in valence (movement in the positive direction) when anticipating large gains than small gains ($p < .001$). In contrast, older adults showed this pattern in the realm of gains only (large vs. small gains, $p < .001$). In the realm of losses, older adults were insensitive to the magnitude of the loss (i.e., they did not experience anticipation of large losses as more negative than small losses, $p = .33$) and did not experience loss anticipation as significantly negative. That is, in older adults, valence showed little or no decrease from baseline levels during anticipation of loss (\$0.50, mean valence change = −0.19, SD = 0.21, and \$5.00, M = 0.02, SD = 0.26) in contrast to younger adults (\$0.50, M = −0.76, SD = 0.19, and \$5.00, M = −1.46, SD = 0.28; upper panel of Figure 2).

Although controlling for baseline ratings adjusts for individual differences in mean affect levels, it does not account for individual differences in the range of ratings. Because the range of movement on the valence dimension was somewhat restricted for older com-

Table 1
Hit Rates by Trial Type: Means (and Standard Errors) of Hit Rates (Number of Hits/Total Trials) for Gain Trials and Loss Trials, Overall and by Individual Trial Type

Domain	Overall	\$0.00	\$0.50	\$5.00
Gain				
Younger adult (N = 20)	0.60 (.04)	0.51 (.05)	0.63 (.04)	0.66 (.04)
Older adult (N = 20)	0.65 (.03)	0.54 (.05)	0.70 (.03)	0.74 (.03)
Loss				
Younger adult (N = 20)	0.57 (.04)	0.51 (.04)	0.60 (.04)	0.59 (.04)
Older adult (N = 20)	0.64 (.03)	0.60 (.03)	0.68 (.04)	0.65 (.03)

Table 2
Affective Reference Points: Means (and Standard Errors) of Baseline Self-Reported Valence and Arousal for 20 Younger and 20 Older Adult Participants

Participants	Baseline valence	Baseline arousal
Younger adults	3.98 (.10)	3.18 (.26)
Older adults	3.96 (.26)	3.67 (.23)

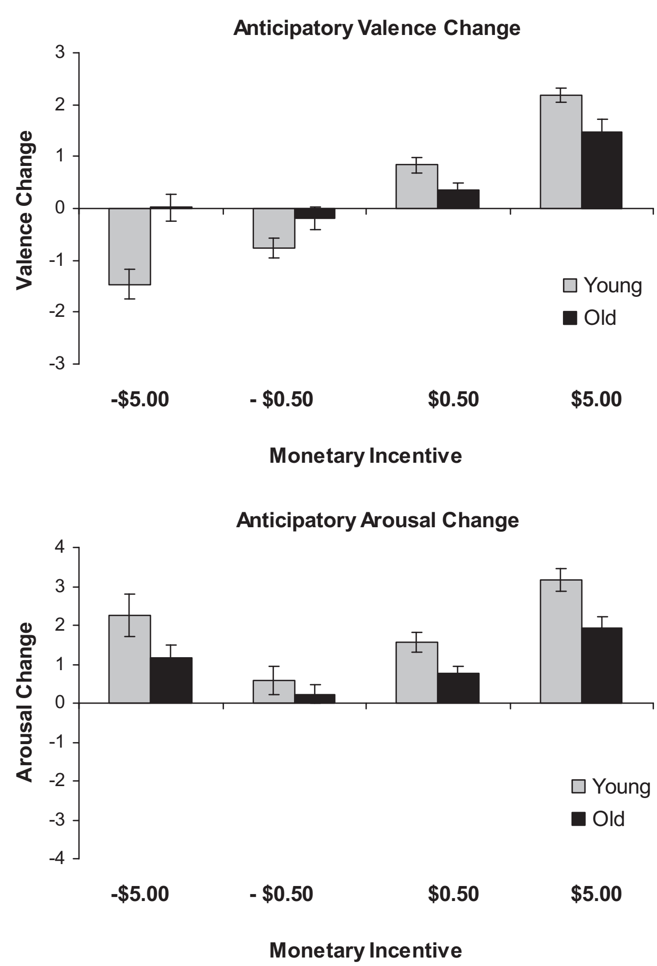

Figure 2. Anticipatory affect change. Means and standard errors of experienced changes in anticipatory affect along valence (upper panel) and arousal (lower panel) dimensions, derived from online self-reports using affect probes while participants played the monetary incentive delay task.

pared with younger adults, we wanted to ensure that the observed differences in anticipatory valence ratings were not an artifact of this potential truncation of scale. Thus, we repeated the above analysis using normalized valence change scores (normalized within participants across all incentive conditions: anticipation, hit outcomes, and miss outcomes, for all levels of incentives). Again, a significant Age × Incentive interaction, $F(1, 38) = 16.88$, $p < .001$, $\eta^2 = .31$, emerged, qualified by an Age × Incentive × Magnitude interaction, $F(1, 38) = 4.62$, $p < .05$, $\eta^2 = .11$. The pattern of findings was similar to that described above for nonstandardized change scores. Specifically, older adults were insensitive to loss magnitude and did not show appreciable decreases in valence during loss anticipation. Thus, when controlling for individual differences in scale use, significant age differences in valence dynamics in the loss domain remained.

Notably, both chronological age and measures of future time perspective were correlated with anticipatory valence change for large and small loss cues but not for gain cues. Chronological age was positively correlated with valence change when anticipating both \$5.00 ($r = .56$, $p < .001$) and \$0.50 losses ($r = .31$, $p = .055$). Future goal orientation was negatively correlated with valence change during anticipation of both \$5.00 ($r = -.39$, $p = .01$) and \$0.50 losses ($r = -.34$, $p < .05$).

Arousal. We explored anticipatory arousal change with a 2 (age group) × 2 (incentive) × 2 (magnitude) ANOVA, controlling for baseline arousal. As hypothesized, there were no age differences in arousal dynamics. There was an expected significant main effect of magnitude, $F(1, 37) = 36.23$, $p < .001$, $\eta^2 = .50$. As expected, larger magnitude incentives increased arousal more than smaller magnitude incentives for both anticipated losses and anticipated gains.[3] Given the restricted range of movement on the arousal dimension among older adults, we also compared groups on normalized arousal change scores. The main effect of magnitude remained, $F(1, 38) = 83.18$, $p = .001$, $\eta^2 = .69$, and no age differences emerged (lower panel of Figure 2).

In sum, our analyses confirmed age-related hypotheses about anticipatory affect dynamics. Older and younger adults differed in their affective response to loss anticipation, but not to gain anticipation, and differences were confined to the valence dimension. Older age and more limited time perspective were associated with smaller valence decreases (less negative affect) during loss anticipation. Arousal increased as the magnitude of the incentive increased, with no significant age differences.

Outcome Dynamics

With respect to outcome affect dynamics, we predicted that older adults would show less valence reactivity to loss outcomes than younger adults because they would not rebound from negatively valenced states during loss anticipation. We predicted that this reactivity would be most apparent in response to the least expected outcomes (i.e., avoided rather than actual losses). This prediction is consistent with prior findings that outcomes that violate expectations evoke the most robust changes in valence (Mellers, 2000; Mellers & McGraw, 2001). Here, we assume that expectations are influenced by the type of trial (loss vs. gain), which drives anticipatory affect and predisposes expectations in the direction of the explicit stakes. Because expectations can also be driven by experiences of success or failure, we also explored the effect of task performance (i.e., overall hit rates) on outcome dynamics.

The following analyses compared ratings with hit and miss outcomes within either the gain or the loss domain, controlling for baseline valence or arousal. Data were missing for several participants in each analysis, all of whom had either no miss outcomes or—in one case—no hit outcomes for \$5.00 gain or loss trials in the block in which the relevant outcome ratings were provided. In all, 15 participants were excluded from one or more analyses; of these, only 3 individuals (2 younger adults and 1 older adult) were excluded from all analyses. Although a higher overall hit rate was associated with exclusion from a larger number of analyses of outcome dynamics ($r = .71$, $p < .001$, $n = 40$),[4] as noted above, participants with higher hit rates did not differ from those with lower hit rates systematically in terms of chronological age, years of education, or any measures of cognitive function or time perspective.

Valence dynamics in the loss domain. Seventeen younger and 16 older adult participants had complete valence rating data in response to \$5.00 hits and misses in the loss domain. As hypothesized, a 2 (age group) × 2 (outcome: hit or miss) ANOVA on valence change in response to loss trial outcomes yielded a significant Age × Outcome interaction, $F(1, 30) = 6.22$, $p < .05$, $\eta^2 = .17$ (see Figure 3). As hypothesized, younger adults reported significantly greater increases in valence than older adults in response to loss hits ($p < .005$), but groups did not differ in their reports of decreases in valence to loss misses ($p = .6$). This finding suggests that older adults may not show large positively valenced rebounds (i.e., relief) associated with avoiding losses because they do not initially experience decreased valence during loss anticipation. Notably, however, older adults do experience increases in negative affect to actual losses, despite lack of anticipatory negative affect to this type of trial.

Valence dynamics in the gain domain. Sixteen younger and only 11 older participants had complete valence rating data in response to \$5.00 hits and misses in the gain domain. A 2 (age group) × 2 (outcome: hit or miss) ANOVA on valence change yielded no significant effects. As hypothesized, there were no age differences in outcome valence dynamics in the gain domain. The expected main effect of outcome did not emerge, possibly because of the smaller number of participants available for this analysis. However, as seen in Figure 3, the pattern of means was in the expected direction, with unexpected outcomes (gain misses) eliciting on average greater valence change than gain hits, and post hoc tests indicated significant within-group differences in valence

[3] As might be expected, there was a also significant main effect of baseline arousal, $F(1, 37) = 19.36$, $p < .001$, $\eta^2 = .34$, qualified by a Magnitude × Baseline Arousal interaction, $F(1, 35) = 11.78$, $p < .001$, $\eta^2 = .24$. Baseline arousal was associated with smaller increases in arousal (*r*s ranging from $-.36$ to $-.66$, all *p*s $< .05$), very likely because of restriction of the possible range of movement on the scale from a high baseline. Individual baseline arousal levels ranged from 1.08 to 5.75 on a scale ranging from 1 to 7. Age and future time perspective were uncorrelated with baseline arousal. The mean baseline was 3.42 ($SD = 1.12$); the mode was 3.92.

[4] There were four analyses of outcome dynamics (valence in the loss domain, valence in the gain domain, arousal in the loss domain, and arousal in the gain domain). Participants were excluded from 0 to 4 analyses as a result of hit rates.

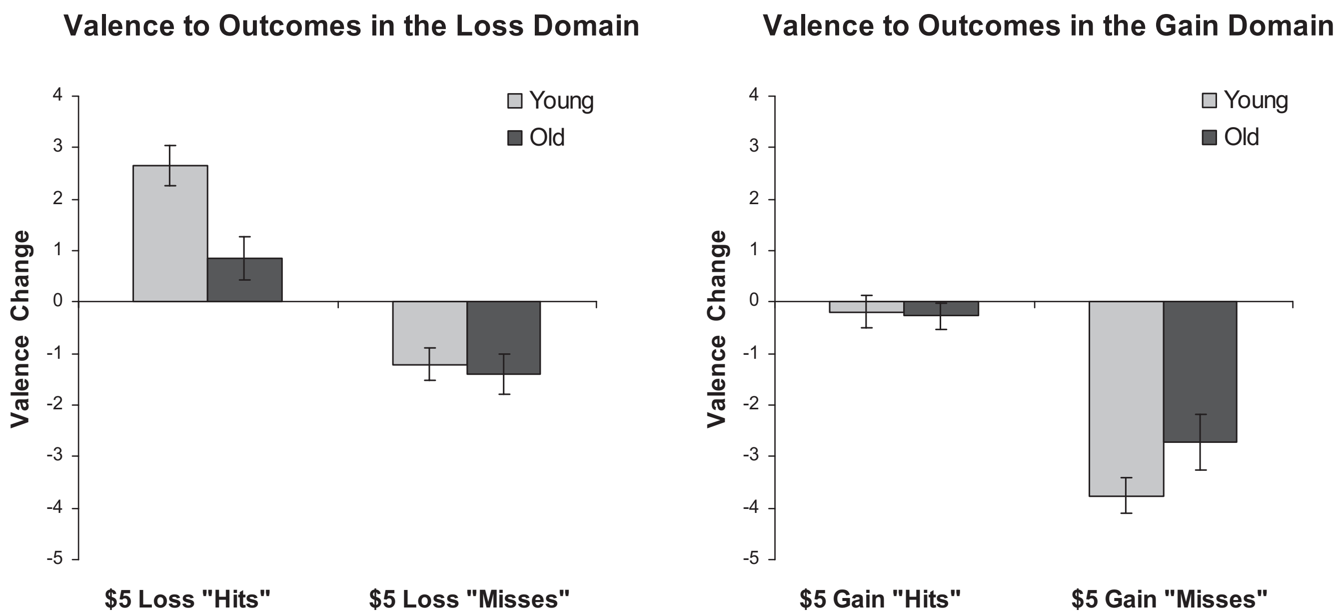

Figure 3. Outcome valence change. Means and standard errors of experienced changes in valence in the loss (left panel) and gain (right panel) domains in the monetary incentive delay task, derived from online self-reports using affect probes.

change for gain hit versus gain miss outcomes (younger adult, $p < .001$; older adult, $p < .001$).

Arousal dynamics in the loss and gain domains. As hypothesized, there were no age differences in outcome arousal dynamics. Seventeen younger and 15 older participants had complete arousal rating data in response to $5.00 hits and misses in the loss domain. The same 17 younger and a different group of 15 older participants had complete arousal rating data in response to $5.00 hits and misses in the gain domain. In both domains, a 2 (age group) $\times$ 2 (outcome: hit or miss) ANOVA on arousal change yielded no significant effects. Notably, outcomes failed to elicit appreciable changes in arousal in either age group (see Figure 4), in contrast to

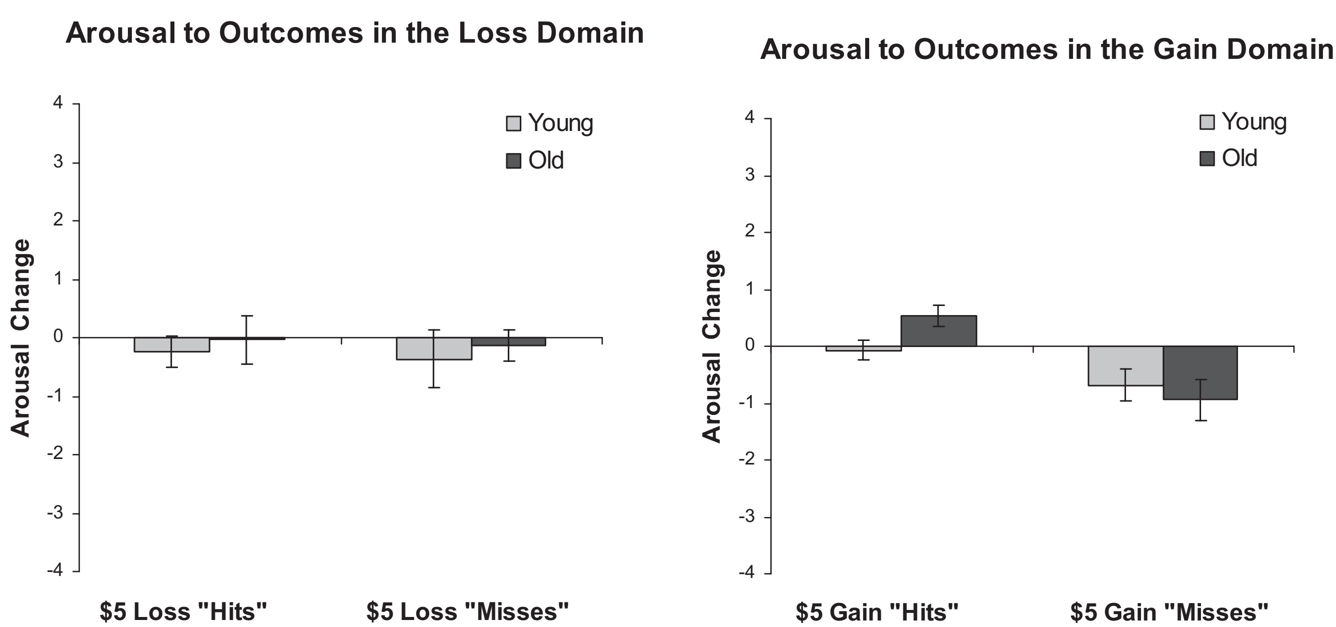

Figure 4. Outcome arousal change. Means and standard errors of experienced changes in arousal in the loss (left panel) and gain (right panel) domains in the monetary incentive delay task, derived from online self-reports using affect probes.

the large increases in arousal observed in the anticipatory phase of the task.

How Did Task Performance Influence Affect Dynamics?

Although overall hit rates approximated our goal of 66% hits, there was individual variation in task performance. Because individual performance on the task might influence expectations, and expectations based on past performance might drive both anticipatory and outcome-related affect dynamics, we explored whether overall hit rates correlated with any of our dependent measures of affect change. Four measures of affect dynamics were related to hit rates—two anticipatory measures and two outcome measures. First, higher overall hit rates were associated with lower anticipatory arousal change in response to both lose $0.50 trials ($r = -.32$, $p < .05$, $n = 40$) and lose $5.00 trials ($r = -.49$, $p < .001$, $n = 40$). This suggests that individuals with better overall performance were less aroused when faced with the prospect of a potential loss, possibly because they knew they were more likely to avoid it. Second, in the outcome phase, higher overall hit rates were associated with greater increases in valence in response to $5.00 gain hit outcomes ($r = .39$, $p < .05$, $n = 39$) and greater increases in arousal in response to $5.00 loss hit outcomes ($r = .33$, $p < .05$, $n = 40$). Thus, people who performed better also experienced the best outcomes as either more positive or more arousing.

Affective Forecasting and Recall

We next examined whether older and younger adults differed in their ability to accurately forecast and recall these changes in anticipatory and outcome-related affect. By parsing forecasts into anticipatory and outcome phases and into valence and arousal dimensions, we endeavored to isolate the source of affective forecasting and/or recall errors while exploring age differences. We hypothesized, on the basis of preliminary studies, that younger adults' forecasting errors would be confined to the arousal dimension, forecasting greater arousal increases to outcomes and smaller increases to anticipation, relative to what they actually experienced. However, we predicted that forecasts of valence dynamics would be accurate in younger adults. We tested two competing hypotheses regarding age differences in affective forecasting and recall. One predicted that older adults would be more accurate than their younger counterparts; the second predicted that they would be inclined to paint the past and future in a more positive light (i.e., to show a positivity effect in forecasting and recall). Both predictions are relevant to socioemotional selectivity theory. On the basis of the finding (reported above) that older adults experienced loss anticipation as arousing but not negative and on our previously reported findings regarding age differences in brain activation during loss anticipation (Samanez-Larkin et al., 2007), we were particularly interested in whether older adults could specifically predict and recall that loss anticipation would elicit increases in arousal but not decreases in valence.

Three participants failed to accurately complete the forecasting and recall questionnaires and were excluded from analyses of forecasted affect. All were older adults (2 men and 1 woman). An additional two older female participants provided incomplete responses and were excluded from analyses on an individual basis. In addition, participants were excluded from analyses on an individual basis if they did not experience hits or misses on one of the relevant outcomes in the MID task.[5] All forecasting analyses used within-subjects 2 (time: forecast and experience or experience and recall) × 3 (phase: anticipation, hit, or miss) ANOVAs focusing on $5.00 magnitude incentives.

Affective Forecasting

Valence forecasting. As hypothesized, valence forecasting was accurate in younger adults and in older adults, who showed no evidence of a positivity effect in valence forecasts. In younger adults, separate 2 (time) × 3 (phase) ANOVAs in the gain and loss domains both yielded significant main effects of phase, loss domain, $n = 17$, $F(2, 32) = 74.91$, $p < .001$, $\eta^2 = .82$, and gain domain, $n = 17$, $F(2, 30) = 183.29$, $p < .001$, $\eta^2 = .92$, but no other significant effects. The lack of an effect of time or a Time × Phase interaction indicates accuracy in affective forecasting. In both domains, and in both forecasts and experiences, unexpected outcomes (loss hits and gain misses) elicited larger valence changes than anticipation or expected outcomes (actual losses or gains; all $ps < .001$).

In older adults, similarly, only significant main effects of phase emerged, loss domain, $n = 14$, $F(1.5, 20.43) = 9.97$, $p < .005$, $\eta^2 = .43$, and gain domain, $n = 9$, $F(2, 16) = 26.86$, $p < .001$, $\eta^2 = .77$, again indicative of accuracy in valence forecasting and likewise accounted for by unexpected outcomes eliciting the largest changes in valence (see Table 3). In the loss domain, we highlight two key findings with respect to older adults' affective forecasts. First, older participants accurately forecasted that loss anticipation would not decrease valence (i.e., elicit negative affective experience), indicating that they have insight into and can predict this aspect of their affective lives. Second, older adults accurately forecasted that actual losses (loss misses) would decrease valence (indicating an awareness of the likelihood of experiencing negative affect to actual negative outcomes rather than a tendency to paint the future in a positive light). Post hoc tests revealed that loss misses were both predicted to and experienced as eliciting greater decreases in valence (increases in negative affect) than loss hits (forecast, $p < .001$; experience, $p < .05$). Although there were relatively few older participants in the gain domain analysis, we note that the pattern of findings is similar to that for younger adults. Namely, in both forecasts and experiences, post hoc tests revealed that unexpected gain misses were reported as eliciting greater decreases in valence (increases in negative affect)

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[5] Overall hit rates were uncorrelated with forecasting and recall errors, suggesting that people who were more successful in the MID task were no better or worse at affective forecasting or recall than those who performed more poorly. Forecasting and recall errors were measured as the magnitude (absolute value) of the difference between experienced affect change and forecast (or recalled) affect change on a given dimension (valence or arousal) for distinct experiences (loss anticipation, $5.00 loss hit, $5.00 loss miss, gain anticipation, $5.00 gain hit, $5.00 gain miss). Errors were calculated independently for each MID task experience. Therefore, it was possible to examine the relation of error measures to overall hit rates in a larger numbers of participants (between 17 to 20 younger adults and between 13 to 17 older adults) than in our larger analyses of forecasting and recall errors. These latter analyses included all task phases: anticipation and hit and miss outcome measures. (Exclusion from an analysis was nearly always because of better performance, i.e., failure to "miss.")

Table 3
Valence Forecasting in the Gain and Loss Domains: Means (and Standard Errors) of Predicted and Experienced Valence Change in the Loss and Gain Domains by Age Group

Domain	Younger		Older	
	Predict	Experience	Predict	Experience
Gain				
Anticipation	1.57 (.22)[†]	2.14 (.15)	1.39 (.45)	1.35 (.15)
Hit	0.56 (.22)[†]	−0.20 (.32)	0.11 (.45)	−0.11 (.27)
Miss	−3.75 (.27)	−3.76 (.35)	−1.78 (.52)	−2.33 (.59)
N	16		9	
Loss				
Anticipation	−1.35 (.17)	−1.20 (.29)	−0.56 (.44)	0.05 (.29)
Hit	2.71 (.35)	2.65 (.38)	1.79 (.50)	1.07 (.42)
Miss	−0.53 (.21)	−1.21 (.30)	−0.64 (.48)	−1.46 (.44)
N	17		14	

Note. Statistical comparisons (Bonferroni-corrected) are with experienced valence change.
[†]Nonsignificant trend, $.05 < p < .08$.

than either gain anticipation (forecast, $p < .05$; experience, $p < .005$) or gain hits (forecast, $p < .005$; experience, $p < .05$).

Arousal forecasting. Younger adults were not as accurate as older adults in predicting their experience of arousal. In younger adults, separate 2 (time) × 3 (phase) ANOVAs in both the gain and the loss domains yielded significant main effects of phase, loss domain, $n = 17$, $F(2, 32) = 21.53$, $p < .001$, $\eta^2 = .57$, and gain domain, $n = 17$, $F(2, 32) = 111.05$, $p < .001$, $\eta^2 = .87$, qualified by significant Time × Phase interactions, loss domain, $F(2, 32) = 3.78$, $p < .05$, $\eta^2 = .19$, and gain domain, $F(2, 32) = 12.59$, $p < .001$, $\eta^2 = .44$, indicating errors in arousal forecasting in younger participants. Planned comparisons confirmed our hypothesis that younger adults would underestimate the amount of arousal increase they would experience during loss anticipation (forecast vs. experience, $p < .05$) and gain anticipation (forecast vs. experience, $p < .005$). Although accurate in forecasting arousal change to loss hit and miss outcomes, they significantly overestimated arousal increases to gain hit ($p < .005$) and miss outcomes ($p < .05$; see Table 4).

Older adults, in contrast, were relatively accurate in predicting their experience of arousal. Among older adults, 14 participants had complete data for an analysis of arousal forecasting in the loss domain. A 2 (time) × 3 (phase) ANOVA yielded no significant effects, indicating accuracy in arousal forecasting. Like younger adults, older adults' arousal increased more during loss anticipation than during loss outcomes, but unlike younger adults, older adults were accurate in forecasting these changes in experience (see Table 4). Thirteen older adults had complete data for an analysis of arousal forecasting in the gain domain. A 2 (time) × 3 (phase) ANOVA yielded a main effect of phase, $F(2, 24) = 27.97$, $p < .001$, $\eta^2 = .70$, qualified by a Time × Phase interaction, $F(1.51, 4.58) = 3.88$, $p = .05$, $\eta^2 = .24$, indicating modest forecasting errors on the arousal dimension. Older adults erred in expecting that outcomes would have no impact on arousal, when on average gain hits increased and gain misses decreased arousal somewhat (forecasts vs. experience, ps $< .05$). However, unlike younger adults, older adults were accurate in forecasting that anticipation of gains would increase arousal more than outcomes (see Table 4).

Affective Recall

We used analyses similar to those used to examine forecasting accuracy to assess accuracy in affective recall. Both immediate and delayed recall of affect dynamics was largely accurate in both younger and older adults (see Tables 5 and 6). Notably, both groups were accurate in recalling anticipatory arousal changes in both the gain and the loss domains on both recall occasions. Thus, on recollection, younger adults can overcome their anticipatory arousal forecasting errors. Older adults made no errors in recall of valence dynamics, accurately recalling age-specific patterns of valence change, with no indications of a positivity effect.

For immediately recalled affect (recalled at the end of the testing session), we used 2 (time: experience and recall) × 3 (phase: anticipation, hit, and miss) ANOVAs focusing on $5.00 magnitude incentives, with separate analyses for the gain and loss domains and for the valence and arousal dimensions. Only two errors in immediate recall of affect dynamics were re-

Table 4
Arousal Forecasting in the Gain and Loss Domains: Means (and Standard Errors) of Predicted and Experienced Arousal Change in the Loss and Gain Domains by Age Group

Domain	Younger		Older	
	Predict	Experience	Predict	Experience
Gain				
Anticipation	2.12 (.24)**	3.35 (.31)	1.74 (.25)	2.03 (.36)
Hit	0.88 (.22)**	−0.07 (.17)	−0.23 (.12)*	0.35 (.169)
Miss	0.24 (.30)*	−0.69 (.29)	−0.08 (.26)*	−0.88 (.43)
N	17		13	
Loss				
Anticipation	1.94 (.44)*	3.05 (.38)	1.15 (.48)	1.41 (.43)
Hit	0.24 (.33)	−0.25 (.27)	0.50 (.51)	0.06 (.43)
Miss	0.53 (.32)	−0.36 (.49)	−0.36 (.61)	−0.05 (.29)
N	17		14	

Note. Statistical comparisons (Bonferroni-corrected) are with experienced arousal change.
*$p < .05$. **$p < .01$.

Table 5
Experienced Versus Recalled Valence Change: Means (and Standard Errors of Experienced and Both Immediate and Delayed Recall of Valence Change in the Loss and Gain Domains by Age Group

	Younger			Older		
Domain	Experience	Immediate recall	Delayed recall	Experience	Immediate recall	Delayed recall
Gain						
Anticipation	2.14 (.15)	2.23 (.23)	2.17 (.23)	1.52 (.21)	1.65 (.45)	1.47 (.23)
Hit	−0.20 (.31)	0.63 (.18)†	0.69 (.15)†	−0.15 (.25)	0.50 (.22)	0.70 (.21)
Miss	−3.76 (.35)	−4.31 (.33)	−4.13 (.35)	−2.50 (.55)	−2.90 (.60)	−2.40 (.58)
N		16			10	
Loss						
Anticipation	−1.20 (.29)	−1.65 (.23)	−1.12 (.33)	0.05 (.29)	−0.49 (.55)	0.05 (.35)
Hit	2.65 (.38)	3.94 (.30)**	3.24 (.43)	1.07 (.42)	2.07 (.68)	1.71 (.47)
Miss	−1.21 (.30)	−0.76 (.24)	−1.41 (.40)	−1.46 (.44)	−1.21 (.61)	−1.21 (.62)
N		17			14	

Note. Statistical comparisons (Bonferroni-corrected) are with experienced valence change.
** $p < .01$. † Nonsignificant trend, $.05 < p < .08$.

vealed, which we report here. First, younger participants made errors in recalling valence dynamics in the loss domain (see Table 5). A 2 (time) × 3 (phase) ANOVA (n = 17) yielded main effects of time, $F(1, 16) = 8.22$, $p = .01$, $\eta^2 = .34$, and phase, $F(1.7, 26.6) = 87.42$, $p < .001$, $\eta^2 = .85$, qualified by a Time × Phase interaction, $F(1.5,8.6) = 5.22$, $p = .05$, $\eta^2 = .25$. Specifically, younger adults exaggerated how much loss hit outcomes increased valence (experience vs. recall, $p < .05$). Second, older participants made errors in recalling arousal dynamics in the gain domain (see Table 6). A 2 (time) × 3 (phase) ANOVA (n = 13) yielded main effects of time, $F(1, 12) = 6.35$, $p = .05$, $\eta^2 = .35$, and phase, $F(1.4, 55) = 17.69$, $p < .001$, $\eta^2 = .60$, qualified by a Time × Phase interaction, $F(1.4,4.2) = 5.30$, $p = .05$, $\eta^2 = .31$. Specifically, older adults recalled gain miss outcomes as slightly more arousing than they actually were (experience vs. recall, $p < .05$).

Delayed recall of affect dynamics was assessed through a mail-back questionnaire completed 10–14 days after the testing session. Again, 2 (time: experience and recall) × 3 (phase: anticipation, hit, and miss) ANOVAs focused on $5.00 magnitude incentives. Delayed recall of valence dynamics was accurate in both groups (see Table 5). Delayed recall of arousal dynamics was less accurate, particularly in the gain domain, with errors in both age groups (see Table 6). In the gain domain, significant Time × Phase interactions in both groups indicated that both younger adults, n = 17, $F(2, 32) = 4.74$, $p < .05$, $\eta^2 = .23$, and older adults, n = 13, $F(2, 24) = 3.93$, $p < .05$, $\eta^2 = .25$, failed to accurately remember that gain misses decreased arousal. Instead, both groups recalled modest arousal increases to these unexpected gain miss outcomes (experience vs. delayed recall: younger adults, $p < .005$, and older adults, $p < .05$). In the loss domain, older adults (n = 14) generally recalled the task as increasing arousal more than it actually did, main effect of time, $F(1, 13) = 5.02$, $p < .05$, $\eta^2 = .28$, although post hoc tests revealed that this error was confined to loss misses (experience vs. delayed recall, $p < .005$).

Discussion

In the present study, older and younger adults were compared on measures of affective forecasting, experienced affect, and recalled affect in a fast-paced, emotionally engaging task in which participants are instructed to win and avoid losing money. Probes of

Table 6
Experienced Versus Recalled Arousal Change: Means (and Standard Errors) of Experienced and Both Immediate and Delayed Recall of Arousal Change in the Loss and Gain Domains by Age Group

	Younger			Older		
Domain	Experience	Immediate recall	Delayed recall	Experience	Immediate recall	Delayed recall
Gain						
Anticipation	3.35 (.31)	3.35 (.33)	3.01 (.42)	2.03 (.36)	2.00 (.34)	1.65 (.23)
Hit	−0.07 (.17)	0.24 (.14)	0.24 (.14)	0.35 (.16)	0.46 (.22)	0.09 (.37)
Miss	−0.69 (.29)	−0.30 (.25)	0.12 (.22)**	−0.88 (.43)	0.23 (.23)*	0.15 (.22)*
N		17			13	
Loss						
Anticipation	3.05 (.38)	3.18 (.38)	3.19 (.40)	1.41 (.43)	1.52 (.54)	1.21 (.36)
Hit	−0.25 (.27)	0.18 (.30)	−0.06 (.22)	0.06 (.43)	0.36 (.39)	0.57 (.33)
Miss	−0.36 (.49)	0.06 (.29)	0.06 (.18)	−0.05 (.29)	0.64 (.53)	0.71 (.22)**
N		17			14	

Note. Statistical comparisons (Bonferroni-corrected) are with experienced arousal change. * $p < .05$. ** $p < .01$.

affective experience on valence and arousal dimensions were inserted into anticipatory and consummatory phases of the task to track participants' dynamic movement in affective space. The study had two main goals. First, we tested hypotheses derived from socioemotional selectivity theory regarding the experienced affect dynamics of older relative to younger adults. Specifically, we tested (a) whether older adults would experience less anticipatory negative affect than younger adults, in line with behavioral and neuroimaging findings (Samanez-Larkin et al., 2007), and (b) whether older adults would consequently show reduced affective response to unexpected outcomes. Second, we explored whether parsing affective ratings into valence and arousal dimensions and anticipatory and consummatory phases could shed light on previously reported affective forecasting errors in younger adults and compared these with patterns of affective forecasting and recall in older adults.

Age Differences in Affective Dynamics in the Loss Domain

With regard to affect dynamics, our findings cohere with hypotheses derived from socioemotional selectivity theory. We observed a distinct profile of anticipatory affect dynamics in older adults. Older adults were insensitive to magnitude of losses but not gains, showing no decreases in valence during anticipation of monetary losses, but increases in valence when anticipating gains. This asymmetric pattern contrasted with younger adults, who reported decreased and increased valence associated with anticipation of losses and gains, respectively. One interpretation of this finding could be that older adults manage to maintain an overall sense of positive well-being by failing to affectively dwell on hypothetical negative outcomes, preferring instead to deal with them—if they must—only when they actually occur. Although dreading negative future states involves hedonic costs that older adults may avoid, anticipatory savoring of hypothetical positive outcomes carries no such costs. Rather, it may serve to enhance emotional well-being in the moment. Thus, although older adults playing the MID task did not experience negative affect when faced with a hypothetical negative outcome, they were willing embrace the hypothetical positive, in addition to its affective correlates. It is important to note that older adults fully experienced negative affect, as evident in their responses to miss outcomes during the task—both to actual monetary losses and to failures to win. These findings do not clarify whether such a hypothesized strategy is conscious or automatic. Overall, though, these findings are consistent with a positivity effect in affect dynamics during anticipatory incentive processing.

An apparent consequence of older adults' lack of affective engagement in hypothetical losses was the subsequent absence of large valence increases on loss avoidance (i.e., the relief" or large reversals in valence dynamics, evident when younger adults avoided a large loss). Older adults may regulate their anticipatory negative affect precisely to avoid emotional swings. Socioemotional selectivity theory suggests that declines in future goal orientation among older adults may lead them to place less emotional stock in future outcomes, and negative outcomes in particular. The present findings suggest that the experience of outcome-related affects such as disappointment, relief, and other emotions related to what might have been may vary with age and may depend heavily on people's initial emotional investment in possible outcomes.

It is presently unclear how reduced negative anticipatory affect might influence older adults' decision making and planning for the future, particularly when decisions involve tradeoffs between positive and negative features. Some findings suggest that older adults do not actively solicit negative information about decision options (Löckenhoff & Carstensen, 2007). Yet, to the best of our knowledge, there is no empirical evidence that suggests that older adults make poorer choices as a result or that affective experience alone drives behavior in these decision tasks. In fact, the absence of negative anticipatory emotion in older adults may facilitate certain types of decision making by allowing for more dispassionate deliberation. Nonetheless, in cases in which older adults need to pay particular attention to potential negative outcomes, efforts to increase attention to these features may be warranted.

Aging Reduces Affective Forecasting Errors

Economic theory often assumes that people can accurately predict the hedonic impact of their choices. However, work by behavioral scientists has demonstrated that although people are rarely wrong about whether events will make them feel good or bad, they are frequently mistaken about just how good or bad that feeling will be (Wilson & Gilbert, 2003). By separately eliciting reports (and predictions and recall) of both anticipatory and outcome-related affect and separately indexing valence and arousal dimensions, we attempted to elucidate the origins of these discrepancies. This approach skirts a number of potential methodological pitfalls. In many affective forecasting studies (like the everyday forecasts people make about future outcomes), participants predict how happy they would feel if a given outcome was obtained. Moreover, participants often make these predictions during an anticipatory period (e.g., a query such as "How happy will you be on the day George Bush is elected?" posed in the weeks leading up to an election). Under these circumstances, individuals may conflate anticipatory and outcome-related affect when asked to make global forecasts about how they will feel in response to an event's outcome. Thus, predicted affect may not match outcome-related affect. Furthermore, individuals may conflate valence with arousal, reporting high levels of happiness either when they experience increases in positive valence or when they experience increases in arousal, or various combinations of both. Finally, predictions might be biased by anticipatory affect itself, which might induce a mood congruency effect.

In the present study, both younger and older participants made accurate predictions about the magnitude and direction of changes in valence during all phases of the task. Older adults' accurate predictions of their distinct pattern of loss-related affective reactions suggest that they have insight into this altered aspect of their affective lives. Discrepancies in affective forecasting were confined to the arousal dimension and primarily evident in younger participants. Younger adults both underestimated increases in arousal during anticipation of gains and losses and overestimated increases in arousal in response to actual monetary gains. Older participants did not make these forecasting errors, suggesting that errors in arousal forecasting may be largely overcome with age. Indeed, it is tempting to speculate that accurate affective forecasting may constitute a core feature of wisdom. Recall of affect on both dimensions was largely accurate in both age groups, although modest errors in arousal recall suggest that people retain a belief that negative outcomes will evoke increased arousal, despite experience to the contrary. Notably, older adults showed no evidence of a positivity bias in affective forecasting or recall.

These findings may offer new insights into the underlying causes of affective forecasting errors. One source of an impact bias might involve the failure to adequately tap the dimensionality and temporal dynamics of affective response. Because actual affective experiences vary on both valence and arousal dimensions and change over time, inaccuracy on one dimension or conflation of anticipatory with outcome affect could generate apparent discrepancies in the forecasting of future hedonic states.

Although people do not typically make mistakes about whether events will make them feel good or bad, considerable evidence suggests that arousing properties of events are more difficult for people to imagine unless they are in the grip of similarly arousing states (Loewenstein & Schkade, 1999). Whereas valence may map more closely onto evaluative schemas used for describing events, people may have greater difficulty appreciating which aspects of events evoke arousal. It is important that when people anticipate future outcomes, the very process of anticipation may evoke arousal. Thus, on the basis of mood congruence, people in anticipatory states may overestimate the amount of arousal they will feel when an outcome occurs. Our findings suggest that people may correct for this bias as they age. Nonetheless, the observed discrepancies in recall of arousal dynamics in both groups, specifically in failures to recall that arousal decreases rather than increases in response to miss outcomes, testify to the difficulties in fully overcoming these hot–cold empathy gaps on the arousal dimension.

The present findings are consistent with recent research suggesting that older and younger adults may process gain and loss information differently. For instance, comparison of older and younger adults on the Iowa Gambling Task revealed that older adults put greater emphasis on gains and less emphasis on losses (Wood, Busemeyer, Koling, Cox, & Davis, 2005). Furthermore, in the same task, older adults respond physiologically to anticipated gains but not to anticipated losses (Denburg, Recknor, Bechara, & Tranel, 2006). Here, fine-grained parsing of the affective processing of gain and loss information in the MID task provided an initial glimpse at the experiential correlates of age differences in affective responses to different incentives and also revealed less responsiveness to anticipation of loss than gain in older adults.

In a recent neuroimaging study using the MID task (Samanez-Larkin et al., 2007), we observed similar patterns of neural activation in younger and older participants during anticipation of gains (increased ventral striatal activation in both groups) but not losses (increased insular and medial caudate activation in younger but not older participants), consistent with the pattern observed in self-reported affect in this study. This coherent emerging pattern suggests that older adults may process information about losses differently from their younger counterparts. Future work is needed to determine whether these differences are due to motivational differences between age groups, as hypothesized by socioemotional selectivity theory, or to neurobiological changes in the aging brain.

These findings may only apply to healthy older adults, such as those recruited to our sample. In addition, the relevance of these findings to behavior in actual choice conditions is purely speculative, given that no choices are made in the MID task by design. However, this task is well suited to exploring basic affective processes involved in the evaluation of incentives and establishes baseline age differences that should be considered in future studies of decision making and aging. Additionally, the MID task is simple and engaging, yet equally unfamiliar to both younger and older adults, and thus provides an appropriate initial comparison task.

Conclusion

The results of this study provide basic information relevant to age differences in incentive processing, specify how younger adults make mistakes in affective forecasting, and imply that older adults might overcome these errors. Improved characterization of affective forecasting in older adults is likely to have implications for understanding how elders make long-term choices that affect their health and well-being (e.g., choosing between health plans, insurance options, retirement investment strategies, medical therapies, or housing arrangements), and for clarifying how they can optimize those choices. Such findings might inform the structuring of decision making for elders and their caregivers regarding future medical care. Obviously, this research cannot address the larger question of whether decisions made in a cold, unemotional state and based on prediction or recollection are more optimal than those made in the heat of an affectively charged episode. At the very least, however, decision makers might benefit from awareness of these discrepancies or heed advice to consider them when planning for the future.

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