Aging, Neuropsychology, and Cognition, 2012, 19 (6), 677–698
http://www.psypress.com/anc
ISSN: 1382-5585 print; 1744-4128 online
http://dx.doi.org/10.1080/13825585.2011.645012

Psychology Press
Taylor & Francis Group

The illusion of the positive: The impact of natural and induced mood on older adults' false recall

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ABSTRACT

Recent research suggests that affective and motivational processes can influence age differences in memory. In the current study, we examine the impact of both natural and induced mood state on age differences in false recall. Older and younger adults performed a version of the Deese–Roediger–McDermott (DRM; Roediger & McDermott, 1995, *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 803) false memory paradigm in either their natural mood state or after a positive or negative mood induction. Results indicated that, after accounting for age differences in basic cognitive function, age-related differences in positive mood during the testing session were related to increased false recall in older adults. Inducing older adults into a positive mood also exacerbated age differences in false memory. In contrast, veridical recall did not appear to be systematically influenced by mood. Together, these results suggest that positive mood states can impact older adults' information processing and potentially increase underlying cognitive age differences.

Keywords: Emotion; Mood; Affect; Memory; Social cognition.

A wealth of accumulating evidence suggests that increasing adult age is associated with an increase in overall positive affect. Daily experience sampling and laboratory studies indicate that relative to young people, older adults experience more positive and fewer negative moods (Carstensen, Pasupathi,

This work was supported by a grant from the National Institute on Aging at the National Institutes of Health (grant number R01 AG020153). The authors wish to thank the following people for help with data collection efforts: Sara Bergman, Christine Casovia, Cassie Dufay, Gilda Ennis, Jake Finan, Viveka Gondha, Brenda Mills, Jenna Ray, Katie Shore, and Carol Sullivan-Riddle.

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Mayr, & Nesselroade, 2000; Mroczek & Kolarz, 1998). The reasons for this shift in dominant mood with age are likely multifaceted, including fewer experienced stressors in older adults (Charles et al., 2010), older adults showing better control over their experience and expression of emotion (Emery & Hess, 2011; Gross et al., 1997; Lawton, Kleban, Rajagopal, & Dean, 1997; Scheibe & Blanchard-Fields, 2009), and older adults' orienting away from negative information in an effort to regulate mood (Isaacowitz, Toner, Goren, & Wilson, 2008).

The majority of research on mood and age has focused on the causes of these age differences. Less attention has been paid to potential consequences of this general mood shift, particularly regarding the possible impact of mood on older adults' information processing style. Previous research in young adults has found that mood can influence qualitative aspects of information processing. For example, people in positive moods rely more on associative and heuristic processing (e.g., Bless et al., 1996), and may be more likely to misremember information than people in negative moods (Forgas, Lahum, & Vargus, 2005; Storbeck & Clore, 2005). When comparing older adults to young adults on certain cognitive tasks, older adults also tend to rely more on associative and heuristic processing (e.g., Adams, 1991; Hess & Tate, 1991) and are often more susceptible to memory confusions (e.g., Giovanello, Kensinger, Wong, & Schacter, 2009; Jacoby, Bishara, Hessels, & Toth, 2005; Karpel, Hoyer, & Toglia, 2001). Although age-related changes in basic cognitive processes can account for much of the age differences in processing style, motivation and emotional factors are known to play a role as well (e.g., Hess, 2005). The current study explores the hypothesis that both natural and induced mood state may influence qualitative age differences in non-emotion related information processing.

Mood Influences on Memory Processes

In the social psychology literature, mood has been found to influence the way people process information. In particular, positive or happy moods tend to produce top-down, heuristic processing that relies heavily on existing schemes (Bless, 2001; Clore et al., 2001),whereas negative moods appear to result in more bottom-up, item-specific processing (e.g., Schwarz, 1990). Recent research has extended these general findings to paradigms designed to induce misremembering (e.g., Forgas et al., 2005; Storbeck & Clore, 2005). In particular, the associative processing style evoked by positive moods may increase the tendency to falsely recall conceptually related but non-presented information, whereas the item-specific processing of negative moods may reduce false memory through decreased use of associative processes (Storbeck & Clore, 2005, 2011). For example, Storbeck and Clore (2005) induced groups of young adults into positive and negative moods before administering a standard version of the Deese–Roediger–McDermott (DRM) False Memory task (Roediger & McDermott, 1995). When presented with lists of words that were all from the same semantic category, people in the negative condition were less likely than people in the neutral or positive conditions to falsely recall the non-presented but semantically similar critical words. In addition, the mood manipulation only affected *false* recall, not *veridical* recall (recall of words that were actually presented).

In a follow-up study, Storbeck and Clore (2011) showed that the effects of mood on false recall were only present when mood was manipulated before encoding, and not when mood was manipulated at retrieval. Negative mood also reduced the likelihood that the critical item came to mind at retrieval, suggesting that mood impacts the associative processes that take place at encoding, rather than influencing retrieval monitoring.

Relationships Between Age, Memory, and Affective Processes

Studies also suggest that older adults have an increased probability of falsely recalling material that was not presented. Older adults are more likely to falsely recall non-presented but semantically related words in the DRM paradigm (e.g., Norman & Schacter, 1997), and are sometimes more likely to incorporate misinformation in laboratory-based eyewitness recall studies (e.g., Karpel et al., 2001). Explanations of these age-related false memory effects include deficits in retrieval monitoring (e.g., Butler, McDaniel, Dornburg, Price, & Roediger, 2004) or reductions in distinctiveness processing in older adults (e.g., Smith, Lozito, & Bayen, 2005; Tun, Wingfield, Rosen, & Blanchard, 1998), each of which are related to age-related cognitive and neural changes (e.g., Giovanello et al., 2009; Jacoby & Rhodes, 2006).

Recent research has also shown that age differences in affective and motivational states can influence age differences in memory processes (Hess & Emery, 2011). For example, compared to younger adults, older adults can show (a) qualitatively different recall of emotional material under similar encoding instructions (Emery & Hess, 2008, 2011; Yang & Ornstein, 2011), (b) impairments of memory when tested under conditions of stereotype threat (Chasteen, Bhattacharyya, Horhota, Tam, & Hasher, 2005; Hess, Auman, Colcombe, & Rahhal, 2003; Hess, Emery, & Queen, 2009), and (c) reduced source memory difficulty when the source judgment is emotional rather than perceptual (May, Rahhal,& Leighton, 2005). In addition, research on false memory for emotional materials suggests that age differences in false memory may sometimes be exacerbated for positive information (Fernandes, Ross, Wiegland, & Schryer, 2008; Piguet, Connally, Krendl, Hout, & Corkin, 2008), with older adults showing greater confidence in their emotional false memories (Gallo, Foster, & Johnson, 2009). Finally, we have recently found that age differences in affect can account for age differences in susceptibility to the misinformation effect, even after accounting for age differences in basic cognitive function (Hess, Popham, Emery, & Elliot, 2012).

With relatively few exceptions, much of the research on affective processing in older adults has focused on memory for emotional material rather than the impact of mood on more traditional laboratory memory tasks. If mood can influence the memory processes in 'non-emotional' tasks, as suggested by the social psychology literature, it is possible that age differences in memory can be exacerbated by natural age differences in mood state. In particular, older adults' naturally increased positive affect may reduce distinctive processing (or encourage heuristic processing) during tests designed to induce false memory.

Induced Mood and Age Differences in Cognitive Performance

Studies of laboratory-based mood inductions suggest that induced mood states can exacerbate age differences in cognitive processes in some cases, though the mechanism for this effect is unclear. For example, Phillips, Smith, and Gilhooly (2002) found that, relative to a neutral condition, both negative and positive mood inductions resulted in greater age differences in performance on the Tower of London task. Mienaltowski and Blanchard-Fields (2005) also found that age differences in the correspondence bias were largest amongst people induced into a negative mood. Both sets of authors suggest that older adults' may be diverting cognitive resources to mood repair or maintenance processes at the cost of cognitive performance, a hypothesis related to the motivational changes proposed by socioemotional selectivity theory (Mather & Knight, 2005). That is, rather than being fully invested in performing their best in the cognitive task, older adults may instead choose to invest in being 'happier', whether that involves maintaining a previous positive state or regulating out of a negative one.

The Current Study

In the current study, we were interested in determining if natural and induced positive moods might influence or exacerbate older adults' tendency to falsely recall conceptually related but non-presented information. Using a paradigm based on Storbeck and Clore (2005), we asked older and younger adults to perform a version of the DRM false memory test either under normal laboratory conditions or after a positive or negative mood induction. Based on Storbeck and Clore's research, we expected both natural and induced mood to primarily affect age differences in false, not veridical, memory. We hypothesized that natural age differences in mood would contribute to age differences in false memory. Because age differences in basic cognitive functions, including processing speed and working memory, are known to account for much of the age differences in memory function (e.g., Butler et al., 2004; McCabe, Roediger, McDaniel, & Balota, 2008; Salthouse, 1996), we first accounted for age differences in these functions before examining the contribution of mood.

Because mood inductions have sometimes been shown to differentially affect older adults, we had two possible hypotheses about induced mood and false recall: (a) mood induction will reduce age differences in false recall, as younger and older adults will be more similar in mood, or (b) mood induction will increase age differences in false recall, as older adults may work harder to maintain positive mood or reduce negative mood after the induction.

METHODS

Participants

The final group of research participants included 107 young adults (ages 17–24 years old; $M = 18.8$, $SD = 1.3$) and 95 older adults (ages 60–86 years old; $M = 70.4$, $SD = 5.8$). Younger adults were recruited from Introductory Psychology courses, and received course credit for participation. Older adults were recruited from the Raleigh, NC area using newspaper and internet advertisements. During the course of the study, participants were screened for possible memory problems using the Short Blessed Orientation-Memory-Concentration test (Katzman et al., 1983) and for possible depression using the short version of the Geriatric Depression Scale (GDS; Sheikh & Yesavage, 1986). Following conventional suggestions (Lezak, Howieson, & Loring, 2004), participants scoring above 6 on the Short Blessed ($N = 9$) or above 9 on the GDS ($N = 3$) were excluded from analysis. An additional four subjects were excluded from analysis for either being influential outliers ($N = 1$), or for not showing the intended mood change as a result of the mood manipulation ($N = 3$). Participant characteristics are shown in Table 1; note that all listed variables showed significant age group differences (all ps $< .001$), but did not differ by condition, or show an Age $\times$ Condition interaction (all ps $> .30$).

Materials

Mood Measures

We chose mood measures that were designed to capture both long-term (‘Trait’) and short-term (‘State’) age differences in affective function. Participants completed the 60-item NEO Five Factor Inventory (Costa & McCrae, 2003), the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) and a six-item questionnaire developed for the current study.

Table 1. Participant characteristics[a]

	Young		Older	
	M	*SD*	*M*	*SD*
Age	18.78	1.28	70.37	5.78
Education	12.71	1.02	16.26	2.20
SF-36: Physical Health	51.66	6.06	45.81	8.39
SF-36: Mental Health	49.80	7.82	55.12	8.42
Digit-Symbol Substitution	85.32	12.26	64.68	12.26
Vocabulary	48.06	7.91	53.42	8.21

[a]All variables showed significant Age Group differences, $ps < .05$, but no Condition or Condition × Age Group differences, $Fs < 1$, $ps > .10$.

Our particular interest in NEO scores was in the personality factors of neuroticism and extraversion, which may be differentially related to negative and positive affect, respectively (Caspi, Roberts, & Shiner, 2005). Neuroticism tends to decline with age, but the relationship between extraversion and age is less straightforward, perhaps reflecting the more multifaceted nature of extraversion (Roberts, Walton, & Viechtbauer, 2006).

Participants completed the PANAS twice, first indicating how they felt 'over the last 30 days' (PANAS-30), and once indicating how they felt 'right now, that is at the present moment' (PANAS-NOW), which were intended to capture 'trait' and 'state' mood, respectively.

The six-item mood questionnaire asked participants to rate how interested, happy, focused, unhappy, calm, and involved they felt, using an 8-point Likert scale. Our primary interest was in responses to the two mood adjectives ('happy' and 'unhappy'), with the remaining adjectives included to disguise the nature of our interest.

Mood Manipulation

Participants in the positive and negative mood manipulation conditions watched 10-minute clips of videos prior to completion of the DRM task. The participants in the positive condition watched a 10-minute segment of the film 'Bill Cosby, Himself'. Participants in the negative condition watched a 10-minute segment of the film 'We are Marshall'. These choices were based on pilot testing in which older and younger adults rated the videos similarly amusing (Bill Cosby) and sad (We are Marshall).

DRM Lists

For the DRM task, 10 lists of 15 words each were chosen from the DRM norms provided by Stadler, Roediger, and McDermott (1999). The words were presented individually on a computer screen at the rate of 1000 ms per item, in descending order of semantic association to the non-presented critical word. The chosen presentation rate was significantly slower than in the Storbeck and Clore (2005) study in order to accommodate the slower processing speed of older adults. After each list was presented, participants were given one minute to recall as many words as they could. Words were recalled aloud and written down by the experimenter. Veridical and false recall were scored by finding the mean proportion of words per list correctly recalled (veridical) and the mean proportion of critical words per list recalled (false).

Cognitive Ability Tests

All participants also completed a short battery of cognitive ability tasks. This battery included the WAIS-III Digit-Symbol subtest, the Plus-Minus task (Miyake et al., 2000) a version of the Stroop task (Stroop, 1935, used as described in Miyake et al., 2000), and a version of the Operation Span task (Turner & Engle, 1989). These measures were designed to capture age difference in basic processing speed and executive function for use as covariates in the memory analyses.

In the Plus-Minus task, participants were given a sheet of paper with three columns of two-digit numbers. In the first column, they were asked to add 3 to each number, in the second column they had to subtract 3 from each number, and in the third column they had to alternate between adding to and subtracting from each number. Following Miyake et al. (2000), the dependent measure was the difference between the time a participant took to complete the third ('switch') column and the average time they took to complete the first two ('non-switch') columns.

In the Stroop task (Stroop, 1935) used by Miyake et al. (2000), participants were presented with a series of X's displayed in six different colors, or color names presented in the six different colors (trials were primarily incongruent), and had to name the color aloud. The dependent measure was the difference in reaction time between the incongruent word trials and the 'X' trials.

In the Operation Span task, participants viewed a series of equation–word pairs (e.g., "$2+3=5$? DOG"). For each equation–word pair, they solved the equation, said whether the equation is true or false, and then said the word aloud. At the end of a series of 2–5 equation–word pairs, they had to recall the words that were presented. The dependent measure was the total number of words recalled correctly.

Participants also completed the WAIS-III vocabulary subtest as a general measure of verbal ability.

Procedure

After giving informed consent, all participants first filled out the NEO-PI and the PANAS with both sets of instructions, and then filled out the first measurement of the six-item mood-rating scale. In introducing the mood-rating scale, participants were told that we were interested in their impressions of different activities they would be performing during the testing session, and they should use the scale to indicate what their 'current mindset' was whenever the experimenter asked. Participants were instructed to 'not think too much' about how they were feeling because we were 'interested in relatively spontaneous reactions'.

Next, participants in the positive and negative mood manipulation conditions watched the 10-minute mood induction segments, followed by an additional administration of the mood-rating scale. Because we were interested in 'typical' testing conditions for people in the control condition, participants in the control condition did not watch a video segment, but instead went right to the DRM task.

After the mood induction (if applicable), participants completed the DRM task. Participants were asked to do additional mood ratings after presentation of the first five lists, and again at the end of the DRM task. After completing the DRM task, participants in the negative mood condition watched a short neutral film clip to eliminate any lingering effects of the negative mood induction. All participants then completed the executive function and remaining cognitive tasks.

RESULTS

The Impact of Natural Mood

We used participants in the control condition to examine the impact of natural mood on veridical and false recall. We first checked to see that age differences in affective states were similar to those found in previous research. Next, we examined correlations between the state and trait mood measures and false and veridical recall, after controlling for general cognitive function. Finally, for the state and trait mood measures that were significantly and consistently related to false and/or veridical recall, we performed mediation analyses to see if mood could mediate the age effects on memory.

Age Differences in Trait and State Affect

As may be seen in Table 2, we found significant age differences in both trait and state affect. Age differences in trait affect were limited to the negative measures. Older adults had lower neuroticism scores than young adults and lower reports of negative affect over the last 30 days, but there were no significant age differences in extraversion or positive affect over the last 30 days. Age differences in state affect, however, showed a different pattern.

Older adults consistently reported more positive affect than younger adults during the testing session, with higher positive PANAS scores at the

TABLE 2. Affective age differences and relationship to DRM task performance

	Young		Older				
	M	*SD*	*M*	*SD*	*t*	Correlation[a] w/ Veridical	Correlation[a] w/ False
Trait Positive Affect							
PANAS-30 Positive	3.57	0.63	3.60	0.65	−0.23	.03	.20
NEO Extraversion	3.65	0.51	3.45	0.58	1.85	.02	.10
Trait Negative Affect							
PANAS-30 Negative	1.84	0.64	1.42	0.45	3.61[b]	.25[b]	.02
NEO Neuroticism	2.39	0.63	2.02	0.54	3.06[b]	.23[b]	−.06
State Positive Affect							
PANAS-Now Positive	2.45	0.59	2.70	0.51	−2.17[b]	−.08	.23[b]
Baseline ‘Happy’	5.06	1.49	6.27	1.35	−4.14[b]	−.09	.23[b]
Mid-DRM ‘Happy’	4.77	1.49	5.49	1.77	−2.20[b]	−.03	.22[b]
End-DRM ‘Happy’	4.81	1.54	5.65	1.90	−2.39[b]	.08	.28[b]
State Negative Affect							
PANAS-Now Negative	1.62	0.31	1.79	0.23	−2.99[b]	−.06	.18
Baseline ‘Unhappy’	1.79	0.93	1.49	0.94	1.56	−.05	−.22[b]
Mid-DRM ‘Unhappy’	1.62	0.82	2.55	1.97	−3.01[b]	−.24[b]	.01
End-DRM ‘Unhappy’	1.74	0.90	2.39	1.82	−2.18[b]	−.17	−.13

[a]Partial correlation, controlling for basic cognitive function.
[b]Significant at $p < .05$.

start of the testing session and higher reports of ‘happy’ mood during DRM task performance. However, older adults also reported more negative affect than young adults at several points, with higher negative PANAS scores at the start of the testing session and higher reports of ‘unhappy’ mood by midpoint of the DRM task. Inspection of the ‘unhappy’ reports over the course of the DRM task appeared to indicate that young and older adults started out with equivalent ‘unhappy’ mood, but older adults’ ‘unhappy’ mood increased over the course of the DRM task whereas younger adults’ did not. This pattern was confirmed with a 2 (Age Group: Young vs. Old) × 3 (Time Point: Baseline vs. Midpoint vs. Endpoint) ANOVA on the ‘unhappy’ scores, which indicated a significant Age Group × Time Point interaction, $F(2, 188) = 11.40$, $p < .001$. A similar ANOVA on ‘happy’ scores revealed only main effects of age group, $F(1, 94) = 9.44$, $p < .01$, and time point, $F(2, 188) = 13.74$, $p < .01$.

To summarize, older adults report less daily negative affect than young adults and more positive affect during the laboratory testing session. Negative affect during the testing session appears to fluctuate more for older adults than for young adults. However, as may be seen in Table 2, both young and older adults report more positive than negative affect for all measures.

Memory Performance

As expected, young adults had higher veridical recall ($M = 0.49$, $SD = 0.07$) than older adults ($M = 0.40$, $SD = 0.08$), $t(94) = 6.44$, $p < .01$, and older adults had higher false recall ($M = 0.38$, $SD = 0.20$) than young adults ($M = 0.29$, $SD = 0.19$), $t(94) = -2.21$, $p < .05$. All remaining memory analyses examining natural mood controlled for a composite measure of general cognitive function.[1] The composite measure was derived from a principal components analysis of Operation Span, Plus-Minus, and Digit-Symbol performance, which accounted for 51% of the variance in cognitive ability scores.[2]

The relationships between veridical recall, false recall, and mood may be seen in the far right columns of Table 2. Consistent with previous findings by Storbeck and Clore (2005, 2011), veridical recall had little relationship to mood during the testing session. Only one of the eight mood measures (negative mood at the DRM task mid-point) was correlated with veridical recall: people who had lower veridical recall reported more negative mood. Veridical recall was, however, consistently positively correlated with both trait negative mood measures.

False recall, in contrast, was consistently related to positive mood during the testing session, with both higher baseline PANAS and higher 'happy' reports related to increased false recall. Negative mood, however, was not consistently related to false recall, with only baseline 'unhappy' scores showing a significant negative correlation with false recall.

In summary, the most consistent relationships between mood and memory were that (1) people higher in negative trait affect had better veridical recall and (2) people higher in positive state affect had higher false recall.

We next used hierarchical linear regression to determine if mood could partially mediate the effects of age on veridical and false recall. To simplify these analyses, we created composite scores for Negative Trait Mood and Positive State Mood using principal components analysis. The Negative Trait Mood factor consisted of NEO Neuroticism and Negative PANAS-30, and accounted for 85% of the variance in scores. The Positive State Mood factor consisted of the 3 'happy' measurements and the Positive PANAS-Now, and accounted for 76% of the variance in scores.

To determine if the effects of age on veridical recall could be mediated by trait mood, we followed the Baron and Kenny (1989) test for mediation (after controlling for general cognitive function). As described above, the first two conditions for mediation were met: Age was both a significant predictor of Negative Trait Mood, $\beta = -0.43$, $p < .01$, and a significant predictor of

[1] The end-of-DRM mood measures were not significantly correlated with performance on the basic cognitive function tests, so we do not believe that lingering mood effects were influencing performance on these scores. The basic cognitive function tests were also uncorrelated with the 'trait' mood measures.

[2] Initial analyses including Stroop performance indicated that Stroop did not load very highly on the general cognitive factor (loading of .3) compared to the other factors (loadings of .6–.8), and so we excluded the Stroop from the analysis. However, using the factor derived by including Stroop did not change the results of the subsequent analyses.

Veridical Recall, $\beta = -0.37$, $p < .01$. When Negative Trait Mood and Age Group were simultaneously used to predict veridical recall, however, the effect of Age Group remained significant, $\beta = -0.32$, $p < .01$, but the effect of Negative Trait Mood on veridical recall was reduced and no longer significant, $\beta = 0.11$, $p = .21$. This suggests that, rather than being a mediator of the age-veridical recall relationship, the relationship between veridical recall and negative trait mood was driven by each variable's relationship to age.

We then performed the same set of analyses to determine if the effects of age on false recall could be mediated by state positive mood. Again the first two conditions for mediation were met: Age was both a significant predictor of Positive State Mood, $\beta = 0.26$, $p < .05$, and a significant predictor of False Recall, $\beta = 0.24$, $p < .05$. When Positive State Mood and Age Group were simultaneously used to predict false recall, the effect of Positive State Mood was significant, $\beta = 0.25$, $p < .05$, but the effect of Age Group on false recall was reduced and no longer significant, $\beta = 0.17$, $p = .14$. This suggests that positive state mood does partially mediate the effects of Age Group on increased false recall.

The Impact of Induced Mood

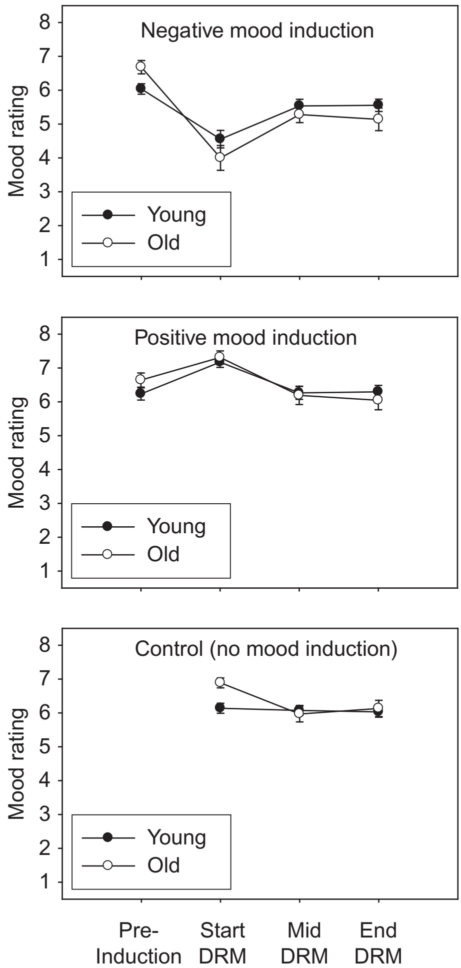
To examine the impact of induced mood on memory, we compared participants in the control condition to participants in the mood induction conditions. We first checked to see whether our mood manipulation was successful in changing people's moods in the intended direction, and whether the experimental groups were in different moods than the control group. We then compared false and veridical recall in the control condition to that in the experimental conditions.

Age and Condition Differences in Mood

Preliminary analyses with positive and negative mood states treated separately yielded a similar pattern of effects for positive and negative mood reports. To simplify reporting, we averaged the mood ratings at each time point, by first reverse-scoring the negative mood report, so that higher numbers represented more positive moods.

We first examined whether our mood induction had the desired effect on participants in the positive and negative conditions. A 2 (Age Group) × 2 (Mood Condition) × 4 (Time Point) ANOVA on mood found a significant main effect of Time Point, $F(3, 306) = 16.19$, $p < .001$, $\eta^2 = .14$, Condition, $F(1, 102) = 39.98$, $p < .001$, $\eta^2 = .28$, a Time Point × Condition Interaction, $F(3, 306) = 64.82$, $p < .001$, $\eta^2 = .39$, and a Time Point × Age Group interaction, $F(3, 306) = 6.27$, $p < .001$, $\eta^2 = .06$; no other effects were significant (p's $> .2$, η^2's $< .02$)

FIGURE 1. Self-reported mood as a function of age, test condition, and testing phase.



As may be seen in Figure 1, the Time Point × Condition interaction indicates that participants in the negative condition showed a decrease in mood after viewing of the video, $t(52) = 8.95$, $p < .001$, and an increase in mood once the DRM task started, $t(52) = -5.28$, $p < .001$, whereas participants in the positive condition showed an increase in mood after viewing of the video, $t(52) = -9.00$, $p < .001$, and a decrease in mood once the DRM task started, $t(52) = 8.52$, $p < .001$. In addition, follow-up tests at each time point indicated that there were no condition differences in mood before the mood induction, $t(104) = 0.30$, $p = .77$, but the positive group reported better mood than the negative group before, $t(104) = 11.64$, $p < .001$, during,

$t(104) = 3.78$, $p < .001$, and after the DRM task, $t(104) = 3.45$, $p = .001$. The Time Point × Age Group interaction indicates that older adults had a more positive mood than young adults at baseline, $t(104) = 2.82$, $p = .006$, but there were no age differences before, $t(104) = 1.14$, $p = .26$, during, $t(104) = 0.99$, $p = .33$, or after the DRM task, $t(104) = 1.54$, $p = .13$.

We next looked to see how the mood of the control participants compared to that of the experimental participants in each of the mood conditions. For this analysis, we did separate contrasts comparing the control to the negative condition, and the control to the positive condition, mirroring the analyses that we expected to perform on the memory data.

In the first 3 (Time Point) × 2 (Condition: Control vs. Negative) × 2 (Age Group) contrast, we found significant effects of Time Point, $F(2, 290) = 7.12$, $p = .001$, $\eta^2 = .05$, Condition, $F(1, 145) = 37.98$, $p < .001$, $\eta^2 = .21$, Time Point × Condition, $F(2, 290) = 42.59$, $p < .001$, $\eta^2 = .23$, and Time Point × Age Group × Condition, $F(2, 290) = 4.53$, $p = .01$, $\eta^2 = .03$. Separate Condition × Age Group analyses at each time point indicated that the Condition × Age Group interaction was significant only at the DRM task Start time point, $F(1, 145) = 9.17$, $p = .003$, with a significant age difference in mood in the control group, $t(94) = 3.61$, $p = .001$, but not the negative group, $t(51) = 1.25$, $p = .22$. At the remaining two time points, only the main effect of condition was significant (p's $< .01$), with people in the negative condition showing worse mood than people in the control condition.

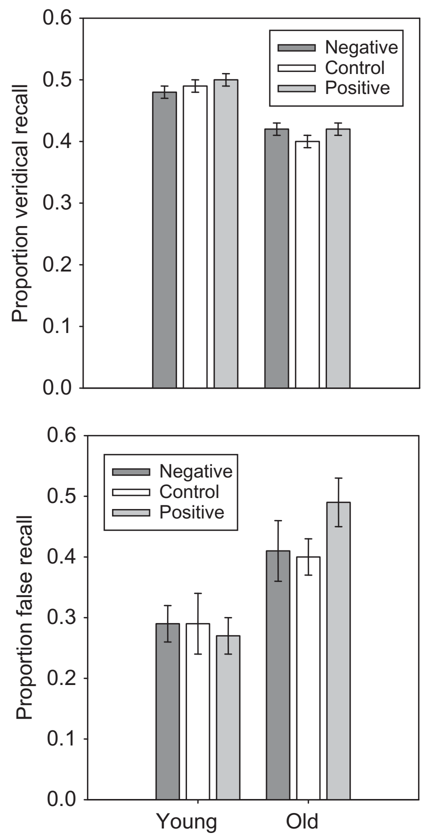
For the 3 (Time Point) × 2 (Condition: Control vs. Positive) × 2 (Age Group) contrast, we found significant effects of Time Point, $F(2, 290) = 53.22$, $p < .001$, $\eta^2 = .27$, Time Point × Condition, $F(2, 290) = 8.17$, $p < .001$, $\eta^2 = .05$, and Time Point × Age Group, $F(2, 290) = 6.53$, $p = .002$, $\eta^2 = .04$. No other effects were significant (p's $> .07$, η^2's $< .02$). Separate analyses at each time point indicated that people in the positive condition reported better moods than the control condition at Time 1, $F(1, 147) = 16.58$, $p < .001$, but not the remaining Time Points (F's < 1.0, p's $> .30$), and older adults reported better moods than younger adults at Time 1, $F(1, 147) = 7.13$, $p = .008$, but not the remaining Time Points (F's < 1.0, p's $> .50$).

In summary, the negative mood induction eliminated the initial age difference in mood and showed persistent effects throughout DRM task performance. In contrast, the positive mood induction primarily impacted mood at the start of DRM task performance. Therefore, any differences in memory performance between the negative and control groups could be attributed to differences in mood throughout the DRM task. Differences in memory performance between the positive and control groups, however, would be attributable only to mood differences at the start of DRM task performance. It should be noted, however, that all groups who underwent mood induction showed drift of mood back toward baseline after the DRM task started.

Memory Performance

The average veridical recall by age group and condition is presented in the top portion of Figure 2.[3] Based on the results of Storbeck and Clore (2005), we predicted that veridical recall would not be affected by mood condition. Separate 2 (Age Group) × 2 (Condition) contrasts comparing Negative to Control, and Positive to Control conditions supported this hypothesis, with condition having no main effect or interaction with age in either contrast (all p's $>$ .10, all η^2's $<$ .02). Both contrasts showed that the only effect on veridical recall was Age Group: $F(1, 145) = 41.17$,

FIGURE 2. Memory performance by age and test condition.



[3] We did not control for general cognitive ability in these memory analyses; doing so, however, did not change the results.

$p < .001$, $\eta^2 = .22$ for Negative vs. Control, and $F(1, 145) = 46.67$, $p < .001$, $\eta^2 = .24$ for Positive vs. Control.

Next, we examined how both the positive and negative mood inductions influenced false recall relative to the control condition. A 2 (Age Group) × 2 (Condition: Negative vs. Control) found significant effects only for Age Group, $F(1, 145) = 8.55$, $p = .004$, $\eta^2 = .05$, (all other p's > .10, η^2's < .01). The 2 (Age Group) × 2 (Condition: Positive vs. Control) contrast found a significant effect of Age Group, $F(1, 145) = 20.33$, $p < .001$, $\eta^2 = .12$, and an Age Group × Condition interaction, $F(1, 145) = 4.73$, $p = .03$, $\eta^2 = .03$. As may be seen in the bottom portion Figure 2, the positive mood condition exacerbated false recall in the older adults.

Because the difference in mood between conditions was largely erased by the midpoint of the DRM task, we also examined whether the effect of the positive mood induction on false memory in the older adults was larger in the first half of the DRM task than in the second. This did not appear to be the case: in a 2 (List Order: First Half vs. Second Half) × 2 (Condition: Positive vs. Control) ANOVA within the older adults, the only significant effect was a main effect of condition, $F(1, 68) = 4.59$, $p = .036$, $\eta^2 = .06$.

DISCUSSION

The main objective of this study was to examine the potential impact of both natural and induced moods on age differences in false recall. We found support for our primary hypothesis that age differences in mood may in part be responsible for age differences in false recall. In the control condition, state positive mood both predicted false recall and acted as a partial mediator between age and false recall. State mood, in contrast, had little impact on veridical recall, and although trait negative mood was positively related to veridical recall, this effect appears to be due to the common relationship with age. Our secondary hypothesis that inducing mood could exacerbate age differences in false recall was partially supported: age differences were exacerbated by positive mood induction, but not negative mood induction. The correlational and experimental findings point to one similar conclusion: positive moods may have a negative impact on older adults' memory, increasing the risk that they will falsely recall non-presented items while leaving their correct recall unaffected.

Impact of Natural Mood

To our knowledge, this is the first study to examine the impact of naturally occurring age differences in mood on performance of a standard laboratory memory task. Our finding that natural mood can influence false, but not veridical, recall supports previous experimental findings (e.g., Storbeck & Clore, 2005), and suggests that age differences in both cognitive and affective function are important for understanding age differences in memory performance.

Previous research suggests that positive affective states may result in decreased caution (Chou, Lee, & Ho, 2007) and/or planning (Phillips et al., 2002) in older adults, intensifying age differences in executive functioning. If this is the case, older adults who were in a positive mood during DRM task performance may have been more likely to report critical lures that came to mind during recall. This would be consistent with the hypothesis that age differences in false recall are primarily due to deficits in retrieval monitoring (e.g., Butler et al., 2004). Alternatively, because research with young adults suggests that positive moods increase the use of associative strategies, older adults who maintain a positive mood may show an increased tendency for the critical words to come to mind. The design of the current study does not permit a dissociation between mood effects at encoding and recall, which could help disentangle these two possibilities. The more recent Storbeck and Clore (2011) paper suggests that mood is likely to exert its effect on false recall through increased access to the critical words at encoding. As suggested by the current study and other research, however, the influence of affect on performance can differ significantly between older and younger adults. Future research should be directed at determining whether mood and executive function influence age differences in false memory through the same or complementary mechanisms.

Impact of Induced Mood

The findings regarding induced mood in older adults showed some overlap with previous research, but some differences. The results that are consistent with previous research include the limitation of mood effects to false recall and the exacerbation of age differences under (some) mood induction conditions. The major difference between this study and previous findings of induction effects on age differences is in the location of the age effect. Age effects were exacerbated in the positive condition in the current study, with previous research showing exacerbation either under negative conditions (Mienaltowski & Blanchard-Fields, 2005) or under any mood induction (Phillips et al., 2002).

One difference of note between the current and previous studies is in the mood-based reaction to the cognitive tests. In the current study, the older and younger adults in both the positive and negative conditions reported very similar mood states. In the negative condition, both older and younger adults report improvement of mood during DRM task performance, to a similar degree. In the positive condition, both younger and older adults report decreasing mood during DRM task performance, to a similar degree. This similarity of reaction across age groups differs from both of the previously reviewed studies. In Phillips et al. (2002), older adults in both induction conditions showed mood improvements during TOL performance, but young adults did not. In Mienaltowski and Blanchard-Fields (2005), younger and older adults in the negative condition showed mood improvements during performance of the Correspondence Bias task, but older adults' mood improved more. It is difficult to argue that the age differences in mood effects in the current study result from age differences in regulation of affective state, as could be the case in previous studies. Instead, it appears that the difference must lie in the other consequences of the induced mood state. We tentatively argue that because positive mood states are a better match to both older adults' emotional/motivational goals and heuristic processing style, they may have a greater impact on older adults' performance on tasks that emphasize heuristic processing.

LIMITATIONS AND FUTURE DIRECTIONS

Although the correlational and experimental findings are relatively consistent, some caution in the interpretation of these findings is warranted. Although we replicated the general findings of Storbeck and Clore (2005, 2011) that mood influences false but not veridical recall, we found no impact of induced mood on young adults' DRM task performance. Previous research has found that the strength of the false memory effect in the DRM task is sensitive to several methodological variables, including the modality of both presentation and recall, and the rate at which the words are presented. Because the study of how mood affects false memory is still relatively novel, it is not yet known how these methodological variables might interact with mood state.

In this study, we used a visual mode of presentation with verbal recall. Visual presentation has previously been found to increase specificity of encoding and reduce false recall (Kellogg, 2001), which could mitigate the effect of mood. Other research has shown, however that using a verbal recall method with visual presentation can reduce false recall (Rummer, Schweppe, & Martin, 2009). It is therefore unclear at this point whether our choice of presentation and/or recall modality could be influencing the failure to replicate.

One methodological difference between this and previous work that could account for the lack of effect in the young is the presentation rate of the DRM words. Storbeck and Clore (2005, 2011) used a 250-ms per item presentation rate, a much faster rate of presentation than used here. Storbeck and Clore chose this rate because it appears to result in the maximum probability that young adults would recall the critical lure, with false recall decreasing at longer presentation rates (McDermott & Watson, 2001). We slowed down the presentation rate to 1000-ms per item because of concerns about age-related slowing, setting our presentation rate at a speed that we hoped would induce heuristic processing in older adults. This change in presentation rate may have been enough to bias the young adults towards item-specific processing, reducing the impact of mood on their performance. Further research on how mood state interacts with of the characteristics of false memory tasks could help determine what the boundary conditions are for mood-related effects.

In addition, although older adults in the positive mood induction condition did have higher false recall than those in the control condition, the differences in mood between those conditions was small and was eliminated by the midpoint of the DRM. It is possible, then, that it is not mood state *per se* that is causing the increase in false memory. It could, instead, be due to motivational differences that result from being in a good mood at the outset of the task. For example, regulatory focus theory (Higgins, 2001) suggests that certain positive mood states (e.g., 'cheerfulness') may be associated with a self-regulatory focus on 'promotion'. Promotion refers to a motivation orientation or state in which people are primarily concerned with 'advancement, aspiration, and accomplishment' (Higgins 2001). Promotion focus can result in a liberal response bias (Crowe & Higgins, 1997), which could lead to an increased reporting of the critical lures in the DRM task. Future research which either measures or manipulates regulatory focus state before DRM task performance could clarify this issue.

CONCLUSIONS

The current study represents a first attempt to quantify possible consequences of age differences in dominant mood on memory performance. Our results suggest that mood may play an important role in explaining commonly observed age differences in memory performance, and that our understanding of the impact of aging on memory may be enhanced by considering such factors in addition to the more commonly emphasized explanatory factors of basic cognitive mechanisms. Our expectation is that mood would be most beneficial in helping to explain qualitative differences in memory performance that could be based in different styles of processing (e.g., schematic processing) rather than more quantitative aspects (e.g., level of performance). Of prime importance is the observation that some characteristics of memory performance in old age, such as elevated false memories in the present study, may be reflections of more than just general cognitive deficits.

Original manuscript received 13 September 2011
Revised manuscript accepted 18 November 2011
First published online 31 January 2012

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