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Replicating the Positivity Effect in Picture Memory in Koreans: Evidence for Cross-Cultural Generalizability

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Older adults' relatively better memory for positive over negative material (positivity effect) has been widely observed in Western samples. This study examined whether a relative preference for positive over negative material is also observed in older Koreans. Younger and older Korean participants viewed images from the International Affective Picture System (IAPS), were tested for recall and recognition of the images, and rated the images for valence. Cultural differences in the valence ratings of images emerged. Once considered, the relative preference for positive over negative material in memory observed in older Koreans was indistinguishable from that observed previously in older Americans.

Keywords: positivity effect, emotional memory, cross-cultural research

A growing body of research on emotion–cognition interactions and aging has provided evidence for a positivity effect in older adults' memory for emotional material. Compared with younger adults, older adults tend to remember relatively less negative material and/or relatively more positive material, leading to an overall higher ratio of positive to negative material with age (Mather & Carstensen, 2005). This age-related difference in emotional memory is found in most, though not all, studies on the topic and across varied types of memory, ranging from recall and recognition memory for pictures and words (Charles, Mather, & Carstensen, 2003; Grühn, Scheibe, & Baltes, 2007; Grühn, Smith, & Baltes, 2005; Leigland, Schulz, & Janowsky, 2004) to autobiographical memory (Kennedy, Mather, & Carstensen, 2004), to memory for choices (Mather & Johnson, 2000), and working memory for emotional material (Mikels, Larkin, Reuter-Lorenz, & Carstensen, 2005).[1]

The positivity effect was initially identified in tests of socioemotional selectivity theory (SST; Carstensen, 1993, 2006), which postulates that the increased ratio of positive to negative material with age in memory and attention reflects changes in goals that increasingly favor emotional well-being. Because what people attend to and remember affects mood, SST predicts that older people are more likely than are younger people to favor positive material in information processing. Goal changes presumably reflect age-related shifts in time horizons. To the extent that remaining time in the future is perceived as limited, people are assumed to be motivated to process emotionally gratifying information more deeply and minimize the impact of emotionally threatening information in order to maintain or increase their emotional well-being. Younger adults, in contrast, are assumed to primarily pursue knowledge-related goals to acquire new information and prepare for their future, which often adaptively demands attention to unpleasant or threatening information (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001).

Given the universality of mortality and its natural association with chronological age, from a theoretical perspective, the preference should appear across diverse cultures. Although research testing hypotheses about social preferences derived from SST has been supported in samples from Hong Kong, Beijing, and Taiwan (Fredrickson & Carstensen, 1990; Fung, Carstensen, & Lutz, 1999; Fung, Lai, & Ng, 2001; F. R. Lang & Carstensen, 1994), research on cognitive processing has been conducted almost exclusively with participants from Western cultures. There are substantial cultural differences between Western and East Asian cultures on a number of psychological dimensions (Elliot, Chirkov, Kim, & Sheldon, 2001; Markus & Kitayama, 1991). For example, U.S. culture, more so than East Asian culture, emphasizes maximizing the experience and expression of positive emotion and minimizing the experience and expression of negative emotion (Heine, Leh-

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[1] In some studies, age differences are driven by older adults' relatively reduced memory for negative material (e.g., Grady, Hongwanishkul, Keightley, Lee, & Hasher, 2007; Grühn et al., 2007), whereas in others they are driven by older adults' relatively enhanced memory for positive material (e.g., Mather & Knight, 2005; Mikels et al., 2005). Both instances likewise lead to a higher ratio of positive to negative material remembered with age. Note that a few studies find no age differences in memory for emotional material (e.g., Comblain, D'Argembeau, Van der Linden, & Aldenhoff, 2004; Denburg, Buchanan, Tranel, & Adolphs, 2003).

man, Markus, & Kitayama, 1999; Kitayama, Markus, & Kurokawa, 2000; Tsai, Levenson, & McCoy, 2006). To the best of our knowledge, only one other study has examined the positivity effect in an Asian culture (Fung et al., 2008) and has failed to find an attentional preference for happy over neutral faces in older Hong Kong Chinese. Fung and colleagues attributed their null effect to collectivist cultures' emphasis on fitting in, making negative information equally meaningful as positive stimuli for regulating emotions.

We hypothesized that the positivity effect in emotional memory would be observed in East Asian cultures but that the emotional valence of specific experimental material is influenced by different cultural ideals (Frijda & Mesquita, 1994; Markus & Kitayama, 1991; Tsai, Knutson, & Fung, 2006). Affect valuation theory (Tsai, Knutson, et al., 2006) maintains that cultures differ in the affective states that individuals value. Westerners tend to place higher value on high-arousal positive material than do East Asians. Consequently, older adults from East Asian cultures may not show a memory advantage for the same material as do older adults from Western cultures, given that it may have a different emotional meaning. However, older adults from East Asian cultures may show relatively better memory than do their younger counterparts for material that they evaluate as positive and negative.

The present study adopted the identical experimental materials and procedures used by Charles et al. (2003, Study 2) to examine the positivity effect in an East Asian sample. Younger and older Koreans were asked to recall and recognize positive, negative, and neutral images from the International Affective Picture System (IAPS; P. J. Lang, Bradley, & Cuthbert, 1997). Reasoning from affect valuation theory, we acknowledged that Koreans may not perceive the affective valence of the experimental materials in the same way as do Americans. Thus, tests of experimental predictions relied on Korean participants' own ratings of the images used in the study. We hypothesized that older adults would remember relatively more positive (pleasant) than negative (unpleasant) pictures, resulting in a higher positive-to-negative ratio of remembered material than that observed in younger adults. We also considered potential confounding variables, such as viewing time for images and mood states, as alternative explanations for potential age-related differences in the positive-to-negative ratio of memorized material.

Method

Participants

Fifty-two younger and 52 older adults living in Seoul, South Korea, participated in the study. Older participants, aged 65–81 years ($M = 70.8$, $SD = 4.2$) were recruited from information board advertisements in a senior welfare center in Seoul, Korea, which has more than 2,000 registered men and women over 55 years of age. Younger participants, aged 19–30 years ($M = 25.1$, $SD = 3.1$), were recruited from flyers in the surrounding community. The two age groups included equal numbers of women and men. The study was approved by the ethics board of Stanford University. Written consent was obtained after we provided participants with information about the study purpose and procedures, as well as about participants' rights.

Younger adults had more years of formal education ($M = 16.61$, $SD = 1.70$) than did older adults ($M = 13.12$, $SD = 3.99$), which is true for the general Korean population and reflects historical shifts in education. Consistent with these educational differences, the two age groups differed on two measures of cognitive ability—the Vocabulary subtest, $F(1, 102) = 18.22$, $p < .001$, and the Digit Symbol subtest, $F(1, 102) = 338.11$, $p < .001$, of the Korean–Wechsler Adult Intelligence Scale (K-WAIS; Korean Society of Clinical Psychology, 1992). Younger adults scored higher than did older adults on both subtests (Digit Symbol: $M_{young} = 75.42$, $SD = 10.67$; $M_{old} = 37.37$, $SD = 10.44$; Vocabulary: $M_{young} = 42.12$, $SD = 10.04$; $M_{old} = 32.27$, $SD = 13.26$). To account for age differences in cognitive performance, control analyses tested the robustness of findings when including both cognitive measures as covariates (see below).

Only participants who reported having relatively good health on the first phone contact were invited to participate in the study. Older adults ($M = 0.75$, $SD = 0.64$) reported better health than did younger adults ($M = 1.04$, $SD = 0.65$), $F(1, 102) = 5.24$, $p = .02$, $MSE = .42$, on a Korean version of the Wahler Health Symptoms Inventory (Cronbach's $\alpha = .92$; Wahler, 1973). The two age groups reported equally low levels of depressive symptoms on the 20-item Center for Epidemiologic Studies—Depression Scale (CES–D; Radloff, 1977): $\alpha = .88$; $M_{young} = 16.54$, $SD = 8.94$; $M_{old} = 17.06$, $SD = 10.61$. No age differences were found in negative mood ($\alpha = .86$; $M_{young} = 1.87$, $SD = 0.66$; $M_{old} = 1.71$, $SD = 0.75$) or positive mood ($\alpha = .90$; $M_{young} = 2.76$, $SD = 0.75$; $M_{old} = 3.02$, $SD = 0.97$) as measured with the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). Older adults reported having a more limited future time perspective ($M = 3.27$, $SD = 1.45$) than did the younger adults ($M = 5.01$, $SD = 1.01$), $F(1, 102) = 50.35$, $p < .001$ (FTP; Lang & Carstensen, 2002). Participants' chronological age and FTP scores were highly correlated, $r = -.57$, $p < .001$.[2]

Materials

Stimuli consisted of 156 images from the IAPS coded as negative ($M = 2.32$, $SD = 0.51$), neutral ($M = 5.01$, $SD = 0.42$), or positive ($M = 7.59$, $SD = 0.35$) in emotional valence on the basis of normative IAPS ratings (collected in American samples). Pictures differed in IAPS arousal ratings; negative pictures ($M = 5.84$, $SD = 0.91$) were rated higher on arousal than were positive ($M = 4.95$, $SD = 0.98$) and neutral pictures ($M = 3.57$, $SD = 1.19$), and positive pictures were rated higher on arousal than were neutral pictures, $F(2, 153) = 63.95$, $p = .001$, $\eta^2 = .46$. Within each valence category, half of the pictures depicted people, and half depicted animals, nature, or inanimate objects. From the 52 pictures in each valence category, half were presented in the initial encoding presentation, and the other half were used to contrast previously seen images in the recognition task. The presentation of the two sets of pictures for each valence category was counterbalanced among participants within each age group, so that each picture served as target and distractor an equal number of times.

[2] All self-report measures were translated into Korean and then back-translated into English by two Korean–English bilingual speakers. Disagreements were resolved through discussion.

Procedure

Consistent with procedures reported in Charles et al. (2003, Study 2), participants were tested individually and sitting in front of a 17-inch computer screen with one experimenter present. Participants were told that they would be viewing a series of images on the screen and to watch them as they would a television. They were asked to press the space bar after they viewed each picture, and another picture would appear. Individuals' viewing time was measured for each picture. Participants viewed 78 consecutive images in random order. After this initial presentation, they spent approximately 20 min completing a demographics questionnaire, the FTP scale, the Wahler Health Symptoms Inventory, and the two cognitive measures.

Participants then completed the recall and recognition memory tasks. To control for potential order effects, half of the participants in each age group started with the recall task, and half started with the recognition task.[3] In the recall task, participants were asked to write down a short description of as many images as they could recall. In the recognition task, the 78 originally viewed pictures and 78 new pictures were presented individually in random order, and participants were asked to indicate whether each image presented was novel or had been presented previously by pressing either a blue (*yes*) or red (*no*) key on the keyboard.

Following the memory tasks, participants rated their mood and depressive symptoms on the PANAS and CES–D. Finally, all pictures were again presented individually, and participants rated each image using a 7-point valence scale ranging from 1 (*very negative*) through 4 (*neutral*) to 7 (*very positive*). The sessions took approximately 1 hr to complete.

Results

Valence Ratings of IAPS Images

We first examined the relative correspondence of Korean participants' valence ratings with the normative IAPS ratings, which are based mainly on responses from American college students. Both younger and older Koreans agreed substantially with the IAPS normative sample ($r_{\text{young-IAPS}} = .94$; $r_{\text{older-IAPS}} = .87$), as well as with each other ($r_{\text{young-older}} = .93$; all ps $= .001$) on the rank ordering of pictures on the valence dimension. To test mean-level differences between the Korean subjective ratings and the IAPS normative ratings, we adjusted the IAPS and Korean ratings to a common metric by *Z*-standardizing them within each rating source (IAPS normative, younger Koreans subjective, older Koreans subjective).

We contrasted each group's mean valence ratings with a 3 (valence: negative, neutral, positive) $\times$ 3 (group: young, old, IAPS) repeated-measures analysis of variance (RM-ANOVA) at the picture level. Valence served as between-pictures factor and Group as within-pictures factor. We obtained a significant Valence $\times$ Group interaction effect, $F(4, 304) = 4.71$, $p < .001$, $\eta^2 = .06$. To follow up this effect, we ran separate analyses of variance for each valence category and group pairing. Younger Koreans' ratings of positive, neutral, and negative pictures did not differ significantly from the normative IAPS ratings from American samples, Fs$(1, 51) \leq 3.44$, ps $\geq .07$. Differences were obtained, however, between older Korean adults' and the IAPS ratings of neutral pictures, $F(1, 51) = 4.97$, $p = .03$, $\eta^2 = .09$, and positive pictures, $F(1, 51) = 15.84$, $p = .001$, $\eta^2 = .24$. Older Koreans rated neutral pictures more positively and positive pictures less positively than are the IAPS norms based on American samples. Older Koreans also tended to rate pictures more positively (or less negatively) than did younger Koreans. These rating differences were more pronounced for neutral images ($M_{\text{young}} = 3.93$, $SE = .08$; $M_{\text{old}} = 4.58$, $SE = .11$) and negative images ($M_{\text{young}} = 2.02$, $SE = .08$; $M_{\text{old}} = 2.60$, $SE = .11$), and less pronounced for positive images ($M_{\text{young}} = 5.52$, $SE = .08$; $M_{\text{old}} = 5.78$, $SE = .11$).

Given rating discrepancies by age group and culture, we categorized images according to each age group's mean valence ratings for the images when analyzing memory performance. Specifically, for each of the two picture sets (one set for initial presentation and another for the recognition task), each age group's mean ratings for all images were sorted and divided into three groups, yielding equal numbers of negative, neutral, and positive images. When two pictures at the boundaries of valence categories were given the same ratings, they were randomly assigned to either one of the two valence groups. This applied to only three cases.

Of the pictures classified as neutral by younger Koreans, older Koreans classified 19% as positive. These images represent mostly items from everyday life, such as household utensils (e.g., plate, mug), vehicles (bus, jet), and nature (e.g., mushroom, horse; see Figure 1 for selected examples). Of the pictures classified as negative by younger Koreans, older adults classified 10% as neutral (e.g., wheelchair, cemetery).[4]

Recall Performance

Two native Korean coders matched all of the written recall responses to the specific images. Their agreement was 93%; discrepancies were resolved by consensus. Of the 104 participants, 11 younger adults and 20 older adults generated one or more responses that could not be matched to the stimuli because they were vague (e.g., animal, peace) or did not match any of the pictures (e.g., panda, monk). There were more uncodeable responses from older adults ($M = 0.85$, $SD = 1.38$) than from younger adults, $M = 0.58$, $SD = 0.89$, $F(1, 102) = 1.40$, $\eta^2 = .24$, $p = .005$, but the overall number was low.

The number of recalled coded images was computed for each of the three valence categories (which were reassigned on the basis of each age group's mean valence ratings, as explained above). The ratio of positive images to negative images recalled was calculated for each participant by dividing the number of recalled positive pictures by the sum of recalled positive and negative pictures. The positive–negative ratio was significantly different between younger and older adults, $F(1, 101) = 4.17$, $p < .05$, $\eta^2 = .04$. As illustrated in Figure 2, results supported the increased relative

[3] Order affected performance on the recall but not the recognition task. When participants completed the recognition task first, both young and old adults later recalled more positive pictures, $F(1, 100) = 4.08$, $p = .046$, $\eta^2 = .04$, than when they completed the recognition task second. Order did not affect recall of negative and neutral pictures (both ps $> .05$). Order was therefore used as a covariate in all recall analyses.

[4] See Appendix for differences by valence for recall and recognition performance.

salience of positive emotional material in older participants. Younger participants recalled a relatively greater proportion of negative images than of positive images (as indicated by a score significantly below .50, $t(51) = -4.02$, $p < .001$), whereas older participants recalled equal proportions of negative and positive images (as indicated by a score nonsignificantly different from .50, $p > .05$).[5]

Control analyses were performed to examine whether viewing times, mood, depressive symptoms, or cognitive functioning could account for age differences in recall performance for positive and negative images. When adding viewing times for negative, neutral, and positive images as covariates in the analysis, the age effect in the positive–negative ratio remained significant, $F(1, 99) = 5.30$, $p = .02$, $\eta^2 = .05$. Similarly, including negative affect (from the PANAS) and depressive symptoms (from the CES–D) as covariates did not change the age effect, $F(1, 98) = 4.47$, $p < .05$, $\eta^2 = .04$. Finally, the age effect, albeit weakened, remained reasonably robust after including the two cognitive measures (Digit-Symbol Coding, Vocabulary) as covariates, $F(1, 97) = 3.40$, $p = .07$, $\eta^2 = .03$.

Recognition Performance

The ratio of positive images relative to negative images correctly recognized was calculated for each participant by dividing the number of correctly recognized positive pictures (hits) by the sum of correctly recognized positive and correctly recognized negative pictures. Again, images were categorized according to each age group's mean valence ratings. The positive–negative ratio was significantly higher for older adults than for younger adults, $F(1, 102) = 15.29$, $p < .001$, $\eta^2 = .13$. As illustrated in Figure 2, this result again supported the relatively higher salience of positive emotion in older adults. Older adults recognized positive images relatively better than they did negative images (as indicated by a score above .50, $t(51) = 1.97$, $p = .06$), whereas younger adults showed the opposite pattern (as indicated by a score significantly below .50, $t(51) = -3.57$, $p < .001$).[6]

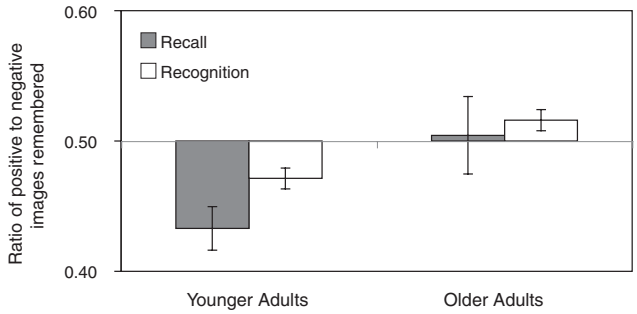

Figure 2. Ratio of positive to negative images remembered in the recall and recognition tasks by age group. Values above .50 indicate better memory for positive relative to negative images. Values below .50 indicate better memory for negative relative to positive images. Classification of valence is based on younger Koreans' mean ratings for younger adults and on older Koreans' mean ratings for older adults. Error bars indicate standard error of the mean.

Additional analyses were again performed to examine whether viewing times, negative mood and depressive symptoms, and cognitive functioning could be responsible for the age differences in recognition. The age effect on the ratio of positive to negative images correctly recognized remained highly significant in all three analyses: $F(1, 99) = 13.45$, $p < .001$, $\eta^2 = .12$ for control of viewing times; $F(1, 100) = 16.58$, $p < .001$, $\eta^2 = .14$ for control of negative affect and depressive symptoms; and $F(1, 99) = 10.95$, $p < .001$, $\eta^2 = .10$ for control of vocabulary and digit-symbol coding.

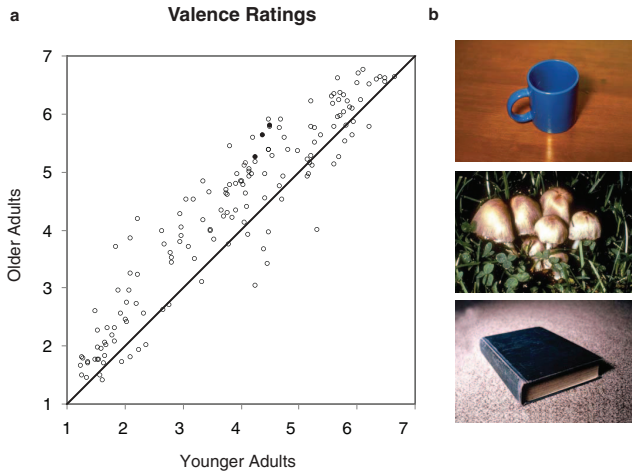

Figure 1. (a) Scatter plot of younger and older Korean adults' valence ratings of the 156 images. The solid line represents perfect fit ($r = 1.00$). Each point represents one image. Most images were rated more positively by older adults than by younger adults (points above perfect fit line). (b) Three sample images were rated as neutral by younger adults but were rated as positive by older adults (mug, IAPS Code 7009; mushrooms, IAPS Code 5530; book, IAPS Code 7090). Sample images are identified with filled markers in the scatter plot.

Discussion

The present study provides evidence for the positivity effect in emotional memory in older Koreans. On the recall task, younger Korean adults showed relatively better recall memory for negative images over positive images, whereas older Korean adults recalled positive images and negative images comparably well. On the recognition task, older Korean adults correctly recognized a greater proportion of positive than negative images, whereas younger Korean adults showed the opposite pattern. Both the recall and recognition tasks revealed significantly different positive-to-negative ratios between age groups, even after controlling for the potential effects of mood and cognitive functioning.

These findings in the Korean sample are remarkably similar to the existing literature based on Western samples (e.g., Charles et al., 2003). Although memory performance in the younger and older Korean samples was poorer than memory performance in the

[5] Results are unchanged when using only the subset of pictures that had the same perceived valence for both age groups (42 positive, 37 neutral, 47 negative), $F(1, 102) = 7.14$, $p < .01$, $\eta^2 = .07$ for recall; and $F(1, 102) = 14.83$, $p < .001$, $\eta^2 = .13$ for recognition.

[6] The same results are obtained when using d′ as a measure of recognition performance, $F(1, 102) = 5.91$, $p < .05$, $\eta^2 = .06$.

American samples in Charles et al.'s study, likely due to differences in education, age differences in the positive-to-negative ratio were essentially indistinguishable. Notably, Fung et al. (2008) failed to observe positivity in attention in older Hong Kong Chinese. One important difference may be the use of Western stimuli categorizations in Asian samples. In the present study, we categorized images into negative, positive, and neutral valence on the basis of mean valence ratings within groups of younger and older Korean participants. By doing so, we allowed for potential cultural and age-related differences in the interpretation of the stimulus set. The younger Korean group in this study did not differ much in their valence ratings from the normative IAPS sample, suggesting low cross-cultural variability in the interpretation of IAPS pictures across groups of younger American and younger Korean adults. Yet, older Koreans' valence ratings differed significantly from the normalized IAPS valence ratings, as well as from their younger Korean counterparts. Older Koreans tended to interpret negative pictures less negatively and they tended to interpret neutral and positive pictures more positively than younger adults.

Many neutral images depicted objects that are part of everyday life, such as household utensils (e.g., clock, basket, plate, lightbulb, umbrella, cup) and nature (e.g., mushrooms on a mountain, rain, bees). Consistent with the strong valuation of low-arousal positive states in East Asian cultures (Tsai, Knutson, et al., 2006), the Korean older adults seem to evaluate these low-arousal, familiar items as "good" things and find positive meaning in them (e.g., in an open-ended debriefing, participants indicated, "Cup is very useful. I feel good about it"; "Mushrooms are precious; I would be very lucky to find these myself"). The shift toward overall more positive valence ratings with age partly maps onto findings from previous age-comparative studies on the perception of the IAPS pictures in American and German samples. Mather and Knight (2005) and Grühn and Scheibe (2008) both found that older adults rated neutral and positive pictures more positively than did younger adults, and Smith, Hillman, and Duley (2005) reported an overall shift toward more positive evaluations of emotional pictures with age. This suggests that the age differences in evaluations obtained in the Korean sample may be a function of both age and culture. Indeed, an age-related positivity shift in valence evaluations might itself be regarded as an effect of the goal shifts postulated by SST. Evaluating negative stimuli as less negative, and neutral and positive images as more positive may help older individuals satisfy their goals of emotional balance and well-being.

This study did not address the possibility that Korean adults evaluated the pictures as more ambivalent (both positive and negative) than is typical in Western samples, as research on dialectical versus synthetic thinking might suggest (Spencer-Rodgers, Peng, Wang, & Hou, 2004). Future research should use separate scales for positive and negative valence to uncover cross-cultural and age-related differences in attitudinal ambivalence and its ramifications for emotional memory. In addition, we obtained only valence ratings from participants; no information on the perceived arousal of the memory material was obtained. People living in collectivistic (interdependent) cultures value low arousal states (e.g., calm, peaceful) more than high arousal states (e.g., excited, enthusiastic, Tsai, Knutson, et al., 2006). Arousal is often confounded with valence, and disentangling the effects of valence and arousal may help to uncover the mechanisms driving the positivity effect across cultures.

Recent studies on response bias and emotional memory (e.g., Dougal & Rotello, 2007; Kapucu, Rotello, Ready, & Seidl, 2008) have raised the possibility that some of the age-specific variability in recognition performance may reflect age differences in response bias. The lack of memory strength ratings in the present study do not allow for analyses that could independently isolate accuracy and bias here. Thus, the possibility that the results are due to response bias cannot be completely ruled out. Finally, although the study focused on positivity effects, supplementary analyses (see Appendix) revealed that older Koreans recognized a greater number of neutral than of emotional pictures. Because this effect did not appear in recall memory and has not emerged reliably in the literature on aging and emotional memory (although see Grühn et al., 2007), we consider it tentative. We will continue to examine recognition memory in our future work. If the finding proves to be replicable, it is theoretically provocative and will merit greater attention. Considered as part of the larger literature, we suspect that it is an unreliable result.

A life-span perspective on memory, aging, and emotion, as viewed through the lens of SST, maintains that memory performance is affected by motivation. This study provides evidence that such effects are not limited to Western cultures. Older Korean adults, similarly to their Western counterparts, tend to forget negative material more readily and better remember materials they favor. This selective preference in memory for positive information can potentially serve to optimize older adults' well-being in the present. In this sense, the increased salience of positive material with age could be understood as a culturally insensitive adaptation process promoting emotional well-being.

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Appendix

Supplementary Analyses

We further analyzed age by valence differences in recall performance using a 3 (valence: positive, negative, neutral) × 2 (age: younger, older) × 2 (order: recall first, recognition first) RM-ANOVA on number of recalled images. Results were similar to those of the previous study by Charles and colleagues (2003). The Age × Valence interaction was significant, $F(2, 101) = 12.32$, $p < .001$, $\eta^2 = .20$. Follow-up paired t tests showed that younger adults recalled a greater number of negative images ($M = 7.33$, $SD = 4.04$) than of positive images, $M = 6.08$, $SD = 3.86$, $t(51) = 3.85$, $p = .001$, and neutral images, $M = 4.04$, $SD = 3.74$; $t(51) = 10.49$, $p = .001$, whereas older adults' recall for negative images ($M = 3.27$, $SD = 2.41$) and positive images ($M = 3.60$, $SD = 2.78$) did not differ ($p > .05$). Older adults also recalled fewer neutral images ($M = 2.15$, $SD = 2.26$) than positive and negative images, both ps $< .001$. The Age × Valence interaction was robust after accounting for viewing times, negative mood, and depressive symptoms (all ps $< .05$) but was slightly weakened to a trend when adding cognitive variables (vocabulary, digit-symbol coding, $p = .06$).

(*Appendix continues*)

We also examined recognition performance for individual valence categories, subtracting the proportion of false alarms from the proportion of hits (see Charles et al., 2003). A 3 (valence) × 2 (age) RM-ANOVA again yielded an Age × Valence interaction effect, $F(2, 101) = 21.13$, $p = .001$, $\eta^2 = .30$. Younger adults recognized a greater number of negative images ($M = .73$, $SD = .26$) than of positive images, $M = .65$, $SD = .26$, $t(51) = 3.55$, $p = .001$, and neutral images, $M = .64$, $SD = .30$; $t(51) = 4.51$, $p = .001$. In contrast, older adults recognized a greater number of positive images ($M = .50$, $SD = .33$) than of negative images, $M = .45$, $SD = .38$; $t(51) = 2.49$, $p = .02$. In addition, somewhat surprisingly, older adults recognized a greater number of neutral images ($M = .54$, $SD = .36$) than positive and negative images, both ps $< .05$. Participants' viewing time, negative mood, and cognitive ability did not change the magnitude and direction of the Age × Valence interaction effect in recognition performance (all ps $< .05$).

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