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Age-Related Effects on Memory for Social Stimuli: The Role of Valence, Arousal, and Emotional Responses

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Abstract

Background—Previous research (Hess, Popham, Dennis, & Emery, 2013) suggested that age-based positivity effects in memory were attenuated with social stimuli. We examined the degree to which this generalized across arousal levels associated with social images. We also examined variations in approach and avoidance responses to images, and how these were differentially related to memory in younger versus older adults.

Methods—In Experiment 1, young (22 – 43 years) and older (65 – 85 years) adults recalled positive and negative social scenes that were high or low in arousal. In Experiment 2, young (20 – 40 years) and older (65 – 83 years) adults viewed and recalled the same scenes under instructions designed to alter arousal, and approach and avoidance ratings for each image were recorded.

Results—In Experiment 1, age differences in recall were confined to high-arousal, negative images, with young adults exhibiting superior memory relative to older adults. There was no evidence of an age-related positivity effect for low arousal social scenes. This result was replicated in Experiment 2, but distancing instructions minimized the age difference in recall for high-arousal, negative images. Approach and avoidance ratings differentially predicted recall across age groups, with stronger associations in the young.

Conclusion—The results are consistent with emerging evidence demonstrating that valence-based biases associated with aging (e.g., positivity effect) are specific to the context and stimulus characteristics. Differences in prediction of recall responses from approach and avoidance ratings across age groups suggested that the observed effects in memory reflected differences in responses to the characteristics of stimuli.

Keywords

Aging; Memory; Emotion; Arousal; Positivity

The intersection of emotion and memory is a salient topic in the study of aging, with several empirical and theoretical perspectives suggesting that affective influences are especially consequential for older relative to younger adults. For example, there is some suggestion that affect may have a disproportionate facilitative effect on memory in older adults due to relative preservation of affective cortical systems associated with modulating memory consolidation (see Kensinger, Allard, & Krendl, 2014). Other perspectives have suggested that high levels of arousal associated with emotional content may, in contrast, be disruptive to older adults due to aging-related declines in cognitive resources (e.g., Labouvie-Vief, Gilet, & Mella, 2014).

One particularly fertile area of research has focused on age differences in memory as a function of the valence of the to-be-remembered information. Much of this work has proceeded within the context of Socioemotional Selectivity Theory (SST; e.g., Carstensen, Isaacowitz, & Charles, 1999), which argues that an age-related increase in chronic social goals focused on emotional outcomes results in a concomitant preference for positive over negative information in service of such outcomes. A recent meta-analysis (Reed, Chan, & Mikels, 2014) demonstrated the reliability of this positivity effect, with the caveat that it was most prevalent in studies in which participants' behavior was unconstrained, and thus presumably reflective of natural tendencies¹. Understanding of the basis for positivity effects is complicated, however, by the fact that they are defined as statistical interactions between age and valence (e.g., Mather & Carstensen, 2005) as opposed to either an age-related enhancement of memory for positive information or a depression in memory for negative information. In addition, there is minimal evidence that positivity in memory is tied to affective outcomes in older adults (Isaacowitz & Blanchard-Fields, 2012). Thus, there is a lack of process-related specificity and functional certainty associated with this phenomenon.

A clearer understanding of the relationship between aging and memory for affective content might be achieved through systematic examination of the effects of stimulus characteristics on performance. For example, Hess, Popham, Dennis, and Emery (2013) recently demonstrated that social content plays an important role in moderating age-related valence influences on memory. Specifically, they found that whereas a positivity effect was evident for nonsocial pictorial stimuli, clear negativity biases were evident young, middle-aged, and older adults' recall of pictures containing people. The absence of a positivity effect for social stimuli—under both constrained and unconstrained conditions—was also observed in two studies by Emery and Hess (2008). These findings suggest that positivity effects may be attenuated by social content.

Consistent with other work showing that social stimuli receive priority in processing (e.g., Harvey, Fossati, & Lepage, 2007; Humphrey & Underwood, 2010; Langton, Law, Burton, & Schweinberger, 2008), Hess et al. (2013) hypothesized that some types of negative social stimuli (e.g., pictures depicting sad or suffering individuals) may activate important social emotional responses, such as empathy or compassion, along with associated prosocial approach tendencies. Indeed, Kim et al. (2009) found that compassionate responses to sad

¹The meta-analysis included studies examining both memory and attention. Unfortunately, no information is provided as to whether the strength of the positivity effect is moderated by task type.

faces were associated with activation of brain structures associated with prosocial motivation (i.e., midbrain–ventral striatum/septal region network), while other research demonstrates that activation of the dorsal-medial prefrontal cortex to emotional suffering in others mediates prosocial and empathic responses (e.g., Mathur, Harada, Lipke, & Chiao, 2010; Masten, Morelli, & Eisenberger, 2011; Rameson, Morelli, & Lieberman, 2012). Such responses may influence attention to and subsequent memory for certain negative stimuli. Consistent with this suggestion, Hess et al. (2013) found that instructing participants to imagine themselves or a close other in the situation depicted in the picture resulted in a reduction in the observed negativity bias, primarily due to an increase in recall for positive social stimuli. This suggests, in part, that the negativity bias associated with social stimuli in that study may be related to an enhanced level of engagement associated with negative social situations.

We extended this initial work focusing on social stimuli by not only examining the impact of valence on memory, but also of arousal levels. Relative to younger adults, older adults' processing and memory are disproportionately disrupted for high-arousal stimuli (e.g., Grühn & Scheibe, 2008; Nashiro & Mather, 2011; Wurm, Labouvie-Vief, Aycocck, Rebucal, & Koch, 2004). Older adults are also more likely to shift their attention away from high-arousal negative stimuli (e.g., Isaacowitz, Wadlinger, Goren, & Wilson, 2006), potentially facilitating memory for non-central aspects of a stimulus as opposed to its negative focal point (e.g., Waring & Kensinger, 2009). Specific to social stimuli, there is also the possibility that arousal level is tied to specific types of depicted emotions that may differentially impact approach and avoidance responses. For example, stimulus faces depicting fear and anger—emotions that are relatively high in arousal—are typically associated with avoidance of these stimuli. Similarly, sadness—a relatively low-arousal emotion—is also often associated with avoidance, but some recent research suggests that empathic responses may reduce such responses (e.g., Paulus & Wentura, 2016; Seidel, Habel, Kirschner, Gur, & Derntl, 2010). Importantly, research has shown that while both approach and avoidance engage cortical systems associated with cognitive engagement (Belayachi et al., 2015), avoidance responses are associated with impaired declarative memory (e.g., Debeer, Raes, Williams, & Hermans, 2013; Murty, LaBar, Hamilton, & Adcock, 2011; Newhagen, 1998).

Based on previous research, it might be expected that avoidance responses associated with negative/high-arousal stimuli might have a disproportionate negative influence on older adults' memory. As already mentioned, high arousal—particularly associated with negative stimuli—appears to be disproportionately disruptive to processing in older adults. In addition, empirical and theoretical work focusing on goals and motivation in later life suggest the avoidance responses may be particularly salient in later life as individuals seek to minimize loss (e.g., Ebner, Freund, & Baltes, 2006; Freund, Hennecke, & Mustafi, 2012; Heckhausen, Wrosch, & Schulz, 2010). The negative social stimuli included in Hess et al. (2013) mainly depicted emotions (e.g., sadness) that would be considered low to moderate in arousal and low in motivational intensity (e.g., Harmon-Jones, Gable, & Price, 2013). Thus, a question remains as to whether a negativity bias in older adults' memory for social stimuli would be obtained for high arousal negative social stimuli depicting emotions potentially associated with different response tendencies.

To address this question, we presented young and older adults with positive and negative social stimuli that also varied in arousal level under unconstrained (i.e., no instructions provided) viewing conditions, and then tested their memory. We expected to replicate our previous finding of an absence of a positivity effect for low-arousal stimuli. However, if negative/high-arousal emotional content is more disruptive to memory processing in older than in younger adults, then a positivity effect would be expected to emerge due to older adults' impaired memory for this material.

Experiment 1

Method

Participants—Participants were recruited from the Raleigh, NC, community through newspaper and internet advertisements. Those who indicated interest in participating were screened for cognitive impairment using the Short Blessed Orientation-Memory-Concentration test (Katzman et al., 1983) with a score below 7 as criterion for participation. Additionally, individuals who had previously participated in a study using similar methods were not eligible for participation. Individuals received an honorarium of \$35 for participation. The final sample consisted of 50 younger (25 women; age range = 22 – 43) and 51 older (21 women; age range = 65 – 85) adults. The age ranges were chosen to create comparable age ranges across the two groups, and participants in each group were distributed relatively evenly across indicated range.

Materials

Picture stimuli: A series of 35 images featuring people were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) for use as target stimuli². Seven pictures were chosen for each of five different categories (see Figure 1 for examples) based on the ratings from the IAPS norms: (a) negative/high-arousal ($M_{\text{valence}} = 2.09$ [$SD = .55$]; $M_{\text{arousal}} = 6.22$ [$SD = .50$]); (b) negative/low-arousal ($M_{\text{valence}} = 2.68$ [$SD = .59$]; $M_{\text{arousal}} = 4.76$ [$SD = .57$]); (c) neutral ($M_{\text{valence}} = 5.14$ [$SD = .48$]; $M_{\text{arousal}} = 3.57$ [$SD = .48$]); (d) positive/low-arousal ($M_{\text{valence}} = 7.40$ [$SD = .50$]; $M_{\text{arousal}} = 4.27$ [$SD = .77$]); and (e) positive/high-arousal ($M_{\text{valence}} = 7.20$ [$SD = .45$]; $M_{\text{arousal}} = 6.68$ [$SD = .92$]). The positive and negative pictures did not differ in distance from the neutral midpoint of the valence scale (5), $t(26) = .17$, $p = .87$. To ensure that there was no unintended covariation of valence and arousal across our picture categories, we conducted separate 2 X 2 (Valence X Arousal) analyses of variance (ANOVA) on the valence ratings and arousal ratings taken from the IAPS norms, with the individual pictures within each of the four categories serving as data sources. For valence ratings, the main effect of valence was significant, $F(1,24) = 539.39$, $p < .001$, $\eta_p^2 = .96$, but the effects of arousal and its interaction with valence were not ($ps > .55$). In contrast, for arousal ratings, the main effect of arousal was significant, $F(1,24) = 39.11$, $p < .001$, $\eta_p^2 = .62$, but the main effect of valence and its interaction with arousal were not ($ps > .31$). These results indicate that valence and arousal varied across stimulus categories independently of each other.

²IAPS pictures used in each category—Negative/high-arousal: 2691, 6212, 6244, 6312, 6550, 6840, 9810; Negative/low-arousal: 2053, 2205, 2276, 2312, 2700, 2900, 3181; Neutral: 2272, 2394, 2410, 2518, 2850, 2890, 7550; Positive/low-arousal: 2165, 2216, 2360, 2395, 2530, 2560, 8497; and Positive/high-arousal: 8116, 8185, 8220, 8370, 8380, 8461, 8490.

We also examined other stimulus characteristics that could potentially confound interpretation of effects associated with valence and arousal. Norms relating to distinctiveness, meaningfulness, familiarity, and memorability (Libkum, Otani, Kern, Viger, & Novak, 2007) were available for all but two neutral and one positive/low-arousal pictures. We chose to include these three pictures because there were no other images in the neutral or positive/low arousal category with norms available that met our selection criteria of depicting a social scene with a central figure. Recall levels for these three pictures were comparable to those of other pictures in the same category, suggesting no idiosyncratic characteristics contributing undue influence on mean recall. One-way ANOVAs using the individual pictures within each category as observations revealed no significant differences between picture categories for any of the four ratings: distinctiveness ($p = .58$), memorability ($p = .76$), familiarity ($p = .21$), and meaningfulness ($p = .093$), indicating that valence and arousal did not covary with other important characteristics that might influence recall.

Affective state: Mood over the prior 30 days was assessed with the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988).

Ability measures: Several cognitive ability measures were used to characterize the sample. Inhibitory control was measured via a Stroop task, whereby mean response time for congruent trials was subtracted from that of incongruent trials. Task-shifting ability was assessed with the Plus/Minus task, using the time required to complete a set of alternating trials entailing adding and subtracting 3 to a series of two-digit numbers minus the mean time required to solve two other sets of problems using only addition or subtraction. The Letter-Number Sequencing, Digit-Symbol Substitution, and Vocabulary Subtests from the Wechsler Adult Intelligence Scale-III (WAIS-III; Wechsler, 1997) were used to measure working memory, processing speed, and verbal ability, respectively.

Health: Self-rated physical and mental health were measured with the SF-36 Health Survey (Ware, 1993). The Geriatric Depression Scale (GDS; Sheikh & Yesavage, 1986) assessed negative affect, with higher scores representing greater levels of depressive symptoms.

Procedure—Prior to testing, participants were mailed and completed a demographic questionnaire, the SF-36, PANAS, and GDS scales, plus several questionnaires unrelated to the present study. Upon arrival at the lab, participants completed the picture memory task after completing another unrelated task. Under unconstrained viewing conditions similar to those of Charles, Mather, and Carstensen (2003), participants viewed a series of pictures, with instructions to “simply watch the pictures as you would a television;” no mention was made of the subsequent memory test. The 35 target pictures were presented in quasi-random order in seven groups, with one picture from each of the five categories randomly sampled within each group. Two neutral buffer pictures were presented at both the beginning and the end. Pictures were presented for 5s each, with 1s between pictures. A delay of about 5 min followed, during which the Digit-Symbol Substitution task was administered. Participants then had a minimum of 3 min to write down a brief description of each picture that they could recall, with instructions to provide sufficient detail such that someone unfamiliar with the pictures would be able to unambiguously identify which one was being described.

Finally, as a manipulation check, participants were presented with all the target pictures used in the memory task in random order and asked to rate the arousal level of each using a 5-point Likert scale (1 = *low*, 5 = *high*). For exploratory purposes, we also asked them to identify which of the following words best characterized the emotion depicted in the picture: anger, fear, sad, contented, or excited. The remaining cognitive tasks were then administered, and participants were debriefed and compensated for their time.

Results

Sample characteristics—Descriptive information about the sample (Table 1) revealed age differences consistent with normative age trends observed elsewhere in the literature.

Picture Recall—Descriptions produced by participants were each coded for recall by two trained judges, who determined whether they could be unambiguously assigned to a specific target picture. Thus, for example, simply labeling a picture as depicting a family was insufficient since several pictures depicted groups that could be construed as such. Additional discriminating information (e.g., family in front of a fireplace) was necessary for unambiguous identification. Inter-rater agreement was high (93.8%), with a third rater settled coding disagreements. Cases in which descriptions were either too vague or ambiguous to match to a particular picture, or did not correspond to any of the displayed pictures, were not coded. The number of such cases was low in both groups: older— $M = 0.35$; younger— $M = 0.46$.

An initial analysis on recall used a 2 X 5 (Age Group X Picture Type [negative/high-arousal vs. negative/low-arousal vs. neutral vs. positive/low-arousal vs. positive/high-arousal]) analysis of variance (ANOVA). Young adults had better overall recall than did older adults ($M_s = .40$ vs. $.32$), $F(1,99) = 14.40$, $p < .001$, $\eta_p^2 = .13$. A significant effect was also obtained for picture type, $F(4,396) = 27.39$, $p < .001$, $\eta_p^2 = .22$, which in turn was moderated by age, $F(4,396) = 3.00$, $p = .02$, $\eta_p^2 = .03$. As seen in Figure 2, there was a clear recall advantage for emotional over neutral pictures, with the interaction based in the age difference in recall of negative/high-arousal pictures, for which older adults had significantly ($p < .001$) lower levels of recall than did younger adults ($M_s = .37$ vs. $.54$). No other age contrasts were significant, although those for neutral ($p = .05$) and positive/high-arousal ($p = .08$) pictures approached significance.

To specifically examine the effects of valence and arousal, we conducted a 2 X 2 X 2 (Age X Valence X Arousal) ANOVA, excluding neutral pictures. In addition to an age effect, $F(1,99) = 14.45$, $p < .001$, $\eta_p^2 = .13$, significant effects were obtained due to valence, $F(1,99) = 13.49$, $p < .001$, $\eta_p^2 = .13$, and its interaction with arousal, $F(1,99) = 4.87$, $p = .03$, $\eta_p^2 = .05$. The interaction reflected the greater recall advantage of negative over positive stimuli for high-arousal items (.44 vs. .35) than for low-arousal items (.41 vs. .38). None of the interactions with age was significant, although all approached significance: Age X Valence, $F(1,99) = 3.39$, $p = .07$, $\eta_p^2 = .03$, Age X Arousal, $F(1,99) = 3.88$, $p = .052$, $\eta_p^2 = .04$, and Age X Valence X Arousal, $F(1,99) = 3.17$, $p = .08$, $\eta_p^2 = .03$. Follow-up analyses within arousal levels revealed that the Age X Valence interaction was significant for high ($p = .004$), but not for low ($p = .99$) arousal pictures. Thus, age differences in memory and

evidence for a positivity effect—as defined by a significant Age X Valence interaction—were limited to high-arousal pictures.

Arousal and emotion ratings—An ANOVA on mean arousal ratings revealed a significant picture effect, $F(4,396) = 301.12$, $p < .001$, $\eta_p^2 = .75$, with the pattern of ratings conforming to our *a priori* categorizations (Figure 3). Importantly, the Age X Picture interaction was not significant ($p = .59$). Older adults did, however, have significantly higher overall arousal ratings than younger adults ($M_s = 3.3$ vs. 2.9), $F(1,99) = 11.11$, $p = .001$, $\eta_p^2 = .10$. However, entering mean arousal as a covariate in the ANOVAs on recall did not change the observed age effects. In addition, participants also identified primary emotion labels that were generally consistent with expectations: (a) negative/high-arousal—anger or fear (88%); (b) negative/low-arousal—sad (75%); (c) positive/high-arousal—excited (87%); and (d) positive/low-arousal—contented (73%). Age differences were minimal.

Discussion

Replicating much previous research, adults of all ages recalled more pictures with emotional content than pictures that were relatively neutral in terms of both valence and arousal. Age differences were also observed in the patterns of memory across levels of affective content, with variation not simply linked to either valence or arousal. Thus, as with previous studies using similar social stimuli (e.g., Emery & Hess, 2008; Hess et al., 2013), there was no clear evidence for a general positivity effect (e.g., independent of stimulus content). Although age differences were stronger for high- than for low-arousal pictures, there was also no evidence that arousal was the main determinant of age differences in recall in that the age effects were primarily associated with negative/high-arousal pictures.

What might account for this very specific effect? As suggested earlier, one possibility has to do with age differences in motivational tendencies associated with the dominant emotions depicted in high and low arousal pictures. Ratings of pictures suggested that the emotional content depicted covaried with arousal and valence. Of particular interest was the fact that the negative/high-arousal stimuli were viewed as depicting emotional content—anger, fear—often associated with strong avoidance responses. In contrast, negative/low-arousal pictures were most often portrayed as depicting sadness, which has been associated with reduced avoidance and, in some cases, approach responses at the behavioral level (e.g., Seidel et al., 2010). Thus, one possible explanation for the obtained disproportionate impact of age on memory for negative/high-arousal stimuli is that these scenes may be more likely to evoke avoidance responses in older adults or, alternatively, that the impact of such responses on processing is more consequential in later life.

Experiment 2

Our second study specifically explored approach and avoidance responses to social stimuli, and the extent to which variations in such responses might covary with age differences in memory. Young and older adults viewed the same pictures used in Experiment 1, but under one of two separate sets of instructions. Specifically, participants were instructed to take either the perspective of the central figure in the depicted scene or that of an observer of the scene, in both cases imagining their response based on the assumed perspective. We

assumed that approach/avoidance tendencies would vary across picture categories, and that the perspective assumed might alter these tendencies. For example, the first-person experience of anger is typically associated with blocked goals and subsequent approach (e.g., Carver & Harmon-Jones, 2009), whereas viewing anger in another is likely to signal threat and induce avoidance responses (e.g., Marsh, Ambady, & Kleck, 2005). This potential manipulation of response tendencies permitted a closer examination of the role of such responses to memory performance and age differences therein. For example, if the age effects in memory for negative/high-arousal stimuli observed in the first study were specifically related to heightened avoidance responses associated with emotions such as anger, then we might expect this effect to change as individuals assume the central character's perspective, which in turn could increase approach responses typically associated with experiencing the emotion of anger.

Method

Participants—A new sample of 32 younger (16 women; age range = 20–40) and 32 older (18 women; age range = 65–83) adults was recruited and screened for cognitive impairment in the same manner as in Experiment 1. Individuals received an honorarium of \$30 for their participation. There were 16 young adults in each of two instructions conditions, whereas an assignment error resulted in only 15 older adults in the central perspective condition and 17 in the observer condition. Age differences in sample characteristics (Table 1) are similar to those in the first study, and 2 X 2 (Age X Instructions) ANOVAs conducted on these characteristics revealed no significant effects due to instruction condition.

Materials

Picture stimuli: The same 35 IAPS images from the first study were used as target stimuli, with each picture presented on a black screen along with a concrete noun in white letters appearing both above and below it.

Ability measures: Cognitive ability was assessed using the Digit-Symbol Substitution and Letter-Number Sequencing Subtests from the Wechsler Adult Intelligence Scale-III (WAIS-III; Wechsler, 1997), and Vocabulary Test II from the Kit of Factor-Referenced Tests (KFRT; Ekstrom, French, Harman, & Derman, 1976).

Procedure: The same procedure used in Experiment 1 was followed, with the following exceptions. Participants were assigned to one of two different conditions. In the central perspective condition, participants were instructed to “take the perspective of the central person in the scene and imagine the emotions he or she might be experiencing.” In the observer condition, participants were told to “imagine the emotions you might experience as an observer of the scene.” In both conditions, participants were told that the words above and below each picture were from a different study and not important in the current study. Picture recall was followed by a word recognition test consisting of the 35 words appearing with the pictures along with 35 distracters.³ Participants then completed a series of paper-and-pencil rating scales. The pictures were presented once again under participant-controlled rate with instructions to continue viewing the pictures from the assigned perspective. For each picture, participants first indicated which of eight emotions (fear, anger, disgust, sad,

awe, excited, contented, or amused) they associated with the picture and then rated its intensity on a 7-point Likert scale. Participants were then instructed to “indicate how likely you would be to approach (avoid) this situation” depicted in each picture using separate 7-point Likert scales.

Results

Picture Recall—Coding of picture descriptions proceeded as before⁴, with inter-rater agreement high (96.5%) and coding disagreements settled by a third rater. Once again, the number of picture descriptions that could not be classified was relatively small in both age groups: older— $M = 0.72$; younger— $M = 0.56$. We examined recall (Figure 3) using a 2 X 2 X 5 (Age Group X Viewing Instructions X Picture Type) ANOVA.⁵ A significant effect was obtained for picture type, $F(4,240) = 7.61, p < .001, \eta_p^2 = .11$, which in turn was moderated by age, $F(4,240) = 4.57, p = .01, \eta_p^2 = .07$. Replicating Experiment 1, this interaction reflected the fact that a significant age effect ($p = .001$) was only observed for negative/high-arousal pictures ($M_{\text{young}} = .50$ vs. $M_{\text{old}} = .31$). A significant Instructions X Picture interaction was also observed, $F(4,240) = 2.43, p = .05, \eta_p^2 = .02$, due primarily to the *observe* instructions enhancing recall relative to the *central* instructions only for negative/low-arousal (.37 vs. .29) pictures. The 3-way interaction did not reach significance ($p = .22$).

As in the first study, the specific effects of valence and arousal were examined using a 2 X 2 X 2 X 2 (Age X Instructions X Valence X Arousal) ANOVA. Significant effects were observed due to valence, $F(1,60) = 6.41, p = .01, \eta_p^2 = .10$, Age X Valence, $F(1,60) = 4.62, p = .04, \eta_p^2 = .07$, Arousal X Valence, $F(1,60) = 21.08, p < .001, \eta_p^2 = .26$, and Age X Arousal X Valence, $F(1,60) = 8.20, p = .006, \eta_p^2 = .12$. There were no significant effects due to instructions ($ps > .15$). Decomposition of the 3-way interaction revealed results consistent with the first study: the Age X Valence interaction was significant for high arousal stimuli—due to the aforementioned age difference for negative/high-arousal items— $F(1,60) = 9.89, p = .003$, but not for low arousal items ($p = .78$). Viewing instructions did not reliably affect age differences in recall.

Picture ratings—We next examined ratings of the stimuli by participants. As before, dominant emotions varied across picture categories, with no significant age differences: (a) negative/high-arousal—anger, disgust, or fear (86%); (b) negative/low-arousal—sad (77%); (c) positive/high-arousal—excited or awe (80%); and (d) positive/low-arousal—contented or amused (71%). Analysis of arousal ratings (Table 2) using a 2 X 2 X 5 (Age Group X Viewing Instructions X Picture Type) ANOVA revealed main effects due to age, $F(1,60) = 11.43, p = .001, \eta_p^2 = .16$, and picture type, $F(4,240) = 89.37, p < .001, \eta_p^2 = .60$, that were similar to those observed in Experiment 1. (Controlling for mean arousal rating again did not alter the obtained age effects in recall.) There was also a significant effect due to

³We included the words to examine the possibility that avoidance responses would be associated with greater attention away from the target stimuli and thus greater memory for words in this case. The recognition memory test for these words revealed no effects due to instructions or picture type ($ps > .19$), and thus the results are not discussed further.

⁴For exploratory purposes, we also examined memory in terms of descriptive information produced (i.e., number of nouns, verbs, adjectives, and adverbs in each correct description). The pattern of results did not differ from that reported.

⁵Given the smaller sample size in this experiment, some concern might be raised regarding power. A priori calculations suggest that the ANOVAs had power of .53 to detect medium effect sizes.

instructions, $F(1,60) = 20.39, p < .001, \eta_p^2 = .25$, and its interaction with picture type, $F(4,240) = 5.34, p < .001, \eta_p^2 = .08$. Participants in the central condition had higher arousal ratings than those in the observer condition ($M_s = 6.11$ vs. 5.55 , respectively), and ratings for all pictures except those in the negative/high-arousal category were significantly higher in the central than in the observer condition. In addition, the strength of this effect was greater for neutral and positive/high-arousal pictures than for the two types of low-arousal pictures. The instructions effect for negative/high-arousal pictures was marginal ($p = .07$), indicating that instructions to take the perspective of an observer were not as successful in reducing emotional responses to these pictures when compared to the other stimuli. No other significant interactions were found.

Approach and avoidance ratings (Table 2) were examined using $2 \times 2 \times 2 \times 2$ (Age X Instructions X Valence X Arousal) ANOVAs to focus on the effects of the last two variables. Approach ratings were higher for positive relative to negative pictures, $F(1,60) = 222.96, p < .001, \eta_p^2 = .79$, and for low-relative to high-arousal pictures, $F(1,60) = 37.47, p < .001, \eta_p^2 = .38$. An interaction between these two factors, $F(1,60) = 10.42, p = .002, \eta_p^2 = .15$, was due to the difference in ratings between high- and low-arousal items being greater for negative (2.6 vs. 3.7) than for positive (5.5 vs. 6.0) stimuli. Instructions also moderated each of these three effects: $F(1,60) = 9.99, p = .002, \eta_p^2 = .14$, $F(1,60) = 10.75, p = .001, \eta_p^2 = .18$, and $F(1,60) = 20.41, p < .001, \eta_p^2 = .25$, respectively. Relative to central instructions, instructions to observe had the effect of reducing approach to positive stimuli and increasing approach to negative/low-arousal pictures; instructions did not affect responses to neutral or negative/high-arousal items. Several age-related effects were observed, including a main effect, $F(1,60) = 10.77, p = .002, \eta_p^2 = .15$, and interactions with arousal, $F(1,60) = 4.18, p = .045, \eta_p^2 = .07$, instructions and valence, $F(1,60) = 5.03, p = .03, \eta_p^2 = .08$, and instructions and arousal, $F(1,60) = 4.59, p = .04, \eta_p^2 = .07$. These effects related to the fact that the impact of instructions across levels of valence was stronger for the young than the old, whereas the opposite was true for arousal.

For avoidance ratings, significant effects due to valence, $F(1,60) = 235.02, p < .001, \eta_p^2 = .80$, arousal, $F(1,60) = 35.56, p < .001, \eta_p^2 = .37$, and their interaction, $F(1,60) = 8.69, p = .005, \eta_p^2 = .13$, mirrored those for approach ratings. Specifically, avoidance was greater for negative than for positive and for high- versus low-arousal stimuli, with the difference between the latter being stronger for negative (5.4 vs. 4.3) than for positive (2.5 vs. 1.9) pictures. Once again, instructions moderated each of these interactions: $F(1,60) = 16.34, p < .001, \eta_p^2 = .21$, $F(1,60) = 10.71, p = .002, \eta_p^2 = .15$, and $F(1,60) = 21.03, p < .001, \eta_p^2 = .26$, respectively. These effects reflected the fact that observer instructions reduced avoidance ratings for negative/low-arousal stimuli, but not negative/high-arousal stimuli. Ratings for positive stimuli were uniformly low. No significant effects due to age were obtained.

Taken together, these ratings were meaningfully related to picture characteristics. Of particular note, approach ratings increased with valence and avoidance ratings decreased, whereas the opposite trend occurred for arousal. Our experimental manipulation also appeared to have a more general effect on emotional response, with arousal ratings being reduced (lower arousal, less variability across picture attributes) when participants assumed

the observer as opposed to central figure perspective. There was also minimal variability across age groups.

Associations between emotional responses and recall: In our final analyses, we examined the relationship between mean ratings and recall using multilevel models. We constructed a set of models that included sample-mean-centered arousal, approach, and avoidance ratings as Level 1 predictors of mean recall for the 4 categories of valenced pictures (i.e., excluding neutral stimuli). Age group was included as a Level 2 predictor (young = referent). We also included all within- and cross-level interaction terms.⁶ A significant Arousal X Approach interaction was observed, $b = -.05$, $t(242) = -2.13$, $p = .04$. Decomposition of this effect by examining the impact of arousal at representative levels of approach (± 1 *SD* from mean) revealed no significant effect at high levels of approach ($b = -.07$, $p = .17$), but a significant positive influence at low levels ($b = .11$, $p = .008$). The Arousal X Avoidance interaction was also significant, $b = -.02$, $t(242) = -3.09$, $p = .002$, and the Age X Approach X Avoidance interaction just missed significance, $b = .02$, $t(242) = 1.96$, $p = .0508$. When the old group was made the reference group in this analysis, the former interaction was no longer significant, indicating that the effect primarily reflected the young adults' performance. Recall estimates (Table 3) revealed an interesting pattern indicating that performance was highest when either approach was best and avoidance low, or approach was low and avoidance high. In other words, memory was high when appetitive or aversive response tendencies were greatest. This pattern was not observed for older adults. Thus, approach and avoidance responses were meaningfully associated with recall, but their impact varied across age groups.

Discussion

The pattern of age differences in memory performance replicated that found in Experiment 1, with the primary age effect reflecting the disproportionately greater memory of younger adults for negative/high-arousal stimuli. We also explored the possibility that motivational responses to the different categories of stimuli might help explain the patterns of performance. We observed that approach and avoidance ratings varied in systematic ways across stimuli with, everything else equal, avoidance being higher for negative and high-arousal stimuli, and approach being greater for positive and low-arousal stimuli. Although some age differences were observed, they were relatively minor, suggesting similar affective responses to each of the five picture categories by the young and older adults.

Our attempt to manipulate responses to the pictures—and potentially patterns of memory performance—was somewhat successful. Arousal ratings were reduced and differences for approach and avoidance ratings between picture categories were attenuated when participants were encouraged to assume a less central perspective when viewing pictures. Of note, however, was the fact that instructions had little impact on responses to negative/high-arousal pictures. Asking participants to take the perspective of an observer while viewing pictures also affected memory, with recall of negative/low-arousal stimuli being significantly

⁶Valence and Instructions were not included given that effects associated with these variables are captured by the three types of ratings.

higher when compared to the central character perspective. Of interest is the fact that the observer instructions resulted in a concomitant increase in approach and decrease in avoidance ratings for these stimuli, suggesting a potential mechanism for the improved recall.

Our more focused examination of these ratings in relation to memory performance revealed general benefits associated with arousal and approach, with recall suffering when both were low. We also found that approach and avoidance responses were associated with memory, but in a somewhat complex way. Specifically, controlling for arousal, young adults recalled the most when appetitive and aversive responses were greatest, suggesting both desirable and undesirable stimuli facilitate retention. Indeed, examination of recall patterns (Figure 3) reveals that performance was highest for the two stimulus categories for which approach and avoidance ratings corresponded to these two extremes. The older adults did not display this pattern, suggesting they responded differently to motivational tendencies. In fact, examination of the estimates in Table 3 indicates a trend toward decreased recall associated with high avoidance, regardless of approach. Together, these data suggest the age differences in memory do not reflect different affective responses to the pictures, but rather differences in the impact of these responses on processing.

General Discussion

The goal of our research was to further examine the impact of information content on adult age differences in memory for positive and negative stimuli. Consistent with earlier studies (Emery & Hess, 2008; Hess et al., 2013), we obtained no evidence of a general positivity effect in memory for social stimuli, even under conditions in which viewing behavior during stimulus presentation was unconstrained. Extending this previous work, we also found that social content in-and-of-itself did not guarantee the absence of a positivity effect, with positivity effects in older adults being dependent on the arousal level associated with the stimuli. Specifically, age differences in valence-based effects on memory were absent for low-arousal stimuli, whereas positivity was observed for high-arousal information, with the age effect specific to younger adults' superior recall of negative/high-arousal stimuli. We further investigated the possibility that the observed age effect in recall might relate to differences in emotional responses to the pictures in each category. Examination of subjective responses to the pictures, however, revealed few differences across age groups. In addition, when systematic differences occurred (e.g., arousal levels), they did not alter the observed age effects in memory. Finally, when affective responses were examined in relation to memory, we found some similarities in effects across age groups. A major difference was observed, however, in the interactive effects of approach and avoidance ratings, with this effect being unique to younger adults. Specifically, their memory was disproportionately enhanced under conditions where motivational tendencies were not in conflict (e.g., low approach, high avoidance).

Together, the results suggest that the observed age differences in memory for social stimuli did not reflect differences in the perceived characteristics of the stimuli, but rather in responses to these characteristics. What is uncertain based on the present data is the nature of this differential response, which is evident primarily with respect to negative/high-arousal

stimuli. Based on previous research (e.g., Isaacowitz et al., 2006), a reasonable possibility is that older adults were more likely than younger adults to divert their attention from such stimuli, consequently reducing memory for these pictures. Studies have suggested that age differences in attention to such information may be especially strong after initial detection, with few age differences in initial orientation (e.g., Hahn, Carlson, Singer, & Gronlund, 2006), but older adults being more likely to voluntarily divert attention subsequently (e.g., Isaacowitz, Allard, Murphy, & Schlangel, 2009; Orgeta, 2011). Continued attention may be particularly important for memory, and the diversion of attention may account for the observed very specific age difference we observed in memory as opposed to a disruption of encoding (e.g., Labouvie-Vief et al., 2014). Support for this attentional perspective can be found in research demonstrating a disproportionate facilitation in older adults' memory for peripheral information relative to that of younger when viewing an arousing central negative object (e.g., Waring & Kensinger, 2009).

Our examination of approach and avoidance responses also provides some clues regarding the impact of motivational tendencies on memory, and potential age differences therein. For younger adults, memory facilitation occurred when the motivational implications of the stimuli were relatively strong and unambiguous, regardless of the nature of these implications. Such implications had less of an impact on memory in older adults. One interpretation of these age differences is that high avoidance responses serve to signal younger adults about the importance of a stimulus, thereby increasing attention and memory for it. In contrast, avoidance responses for older adults may be more closely tied to *actual* avoidance, perhaps accounting for the apparent, but admittedly nonsignificant trend suggestive of a negative relationship between avoidance and memory. Obviously, the present results are only suggestive, but appear to warrant further exploration of the impact of approach and avoidance responses on memory and the extent to which they may be responsible for observed age effect due to arousal and valence.

Several caveats in interpretation of the present results are necessary. First, affective ratings were obtained after all pictures had been viewed as opposed to concurrently. Thus, associations between these responses and memory may have been attenuated. Second, other indices of approach-avoidance, such as diversion of gaze (e.g., Isaacowitz et al., 2006) or flexion-extension responses (e.g., Cacioppo, Priester, & Berntson, 1993), might provide more sensitive indices than subjective ratings. Third, IAPS stimuli are complex, potentially resulting in complex responses. Although we attempted to assess this complexity using multiple measures, interpretation of age differences in memory is complicated by inability to control focus of attention. In addition, it is likely that these pictures are associated with multiple emotions, further complicating our ability to understand linkages between specific emotion-related responses and age differences in memory. This complexity may have also resulted in less systematic responses across participants related to our perspective manipulation in Experiment 2 due to participant characteristics potentially interacting with focus of attention and the specific attributes of the pictures. Future studies would do well by using stimuli with greater specificity with respect to emotional content and associated motivational responses.

Although stimuli in our study were selected to vary along the intended dimensions of interest while controlling for potential confounds that could affect memory, we did not control for the age relevance of the material. Some research (e.g., Kunzmann, & Grühn, 2005; Streubel & Kunzmann, 2011) has suggested that older adults' responses to emotional materials may be particularly sensitive to relevance. Although we do not have reason to believe that this factor compromised our results, it would certainly be reasonable to explore the impact of this factor on motivation-memory linkages. A final potential issue has to do with expectations of recall. We did not have a posttest assessment of such expectations, and thus differences in across age or experimental conditions may have impacted our results by influencing processing strategies. With regard to this, we would simply note that our previous work using similar instructions has generally resulted in both young and older adults having low expectations of a memory test.

In conclusion, the results of this study build on previous work demonstrating that stimulus content moderates age-based valence effects on memory. Consistent with prior research using social stimuli, we did not obtain general evidence for age-related positivity in memory. However, we also did not find that the previously observed negativity bias in young and older adults' memory generalized across all levels of social content. Whereas social content might increase stimulus salience irrespective of age—potentially resulting in similar valence-based biases across age groups—we obtained evidence that arousal levels associated with specific categories of stimuli moderated such effects. Approach and avoidance ratings provided by participants suggested different motivational tendencies to different categories of emotional stimuli, presumably tied to the emotions represented in such stimuli. Variations across age groups in associations between these rated tendencies and memory suggest that age effects in memory are based in responses to stimulus characteristics, as opposed to perceptions of these characteristics. Taken together, our findings indicate that the nature of age-based valence effects on memory is quite variable, even under unconstrained circumstances when hypothesized chronic goal processes should be most evident. Thus, a more nuanced approach that goes beyond a simple focus on valence is required to further our understanding of these effects.

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Figure 1.
Examples of IAPS pictures from each of the five categories.

Figure 2.
Experiment 1: Mean proportion of picture recall by age and picture type.

Figure 3.
Experiment 1: Mean arousal ratings by age and picture type.

Figure 4.
Recall in Experiment 2 as a function of age, instructions, and picture type.

Table 1

Mean (SD) Participant Characteristics

Measure	Experiment 1		Experiment 2	
	Young	Old	Young	Old
Age *	33.7 (5.4)	75.3 (5.6) *	30.0 (5.8)	71.4 (5.4) *
Education	16.6 (2.0)	16.2 (2.2)	16.8 (2.3)	15.8 (2.4)
SF36 Physical health	49.2 (5.8)	46.9 (5.6)	47.9 (5.9)	47.5 (3.2)
SF36 Mental health *	49.9 (10.4)	55.9 (7.5) *	50.6 (8.5)	55.1 (7.7) *
GDS	2.3 (2.4)	1.8 (2.2)	1.5 (1.8)	1.7 (1.8)
Letter-Number Sequencing *	12.09 (3.5)	9.7 (2.2) *	11.9 (3.1)	10.4 (2.1) *
Digit-Symbol Substitution *	84.0 (14.0)	60.1 (16.5) *	93.0 (13.7)	65.9 (11.2) *
Vocabulary ^I	51.5 (7.0)	51.5 (7.4)	19.1 (6.0)	25.5 (5.7) *
Plus-Minus *	22.9 (12.1)	35.9 (24.0) *	-	-
Stroop *	13.7 (5.1)	27.4 (16.9) *	-	-
PANAS Positive affect	3.4 (.6)	3.5 (.7)	3.4 (.7)	3.6 (.4)
PANAS Negative affect	1.6 (.5)	1.5 (.5)	1.2 (.7)	1.2 (.2)

^I Experiment 1 used the WAIS III vocabulary test. Experiment 2 used the KFRT Vocabulary Test 2.

* Age group difference significant within experiment at $p < .05$.

Table 2

Experiment 2: Mean Ratings (SD) for Each Picture Category

Picture Type	Central Instructions			Observer Instructions		
	Arousal	Approach	Avoidance	Arousal	Approach	Avoidance
Young Adults						
Positive/High-Arousal	6.4 (0.4)	5.8 (0.8)	2.2 (1.1)	5.6 (0.8)	4.9 (1.3)	2.6 (1.0)
Positive/Low-Arousal	6.1 (0.5)	6.2 (0.9)	1.8 (1.2)	5.5 (0.7)	5.2 (1.2)	2.4 (1.1)
Neutral	5.0 (0.9)	4.5 (0.6)	3.3 (0.9)	3.9 (1.1)	4.4 (1.1)	3.0 (1.2)
Negative/Low-Arousal	6.0 (0.5)	2.5 (1.1)	5.5 (1.0)	5.6 (0.9)	3.8 (1.4)	3.7 (1.6)
Negative/High-Arousal	6.2 (0.7)	2.2 (1.1)	5.8 (0.9)	5.8 (0.7)	2.7 (1.2)	5.1 (1.3)
Older Adults						
Positive/High-Arousal	6.6 (0.5)	5.8 (1.2)	2.3 (1.2)	5.9 (0.7)	5.4 (1.0)	2.7 (1.0)
Positive/Low-Arousal	6.4 (0.4)	6.3 (1.0)	1.7 (0.9)	6.1 (0.5)	6.3 (0.7)	1.8 (0.8)
Neutral	5.4 (0.7)	4.7 (0.7)	3.3 (0.7)	4.4 (1.2)	4.8 (1.1)	2.7 (1.0)
Negative/Low-Arousal	6.4 (0.5)	3.6 (1.1)	5.0 (1.2)	6.1 (0.6)	45.0 (1.3)	3.1 (1.2)
Negative/High-Arousal	6.7 (0.3)	3.4 (1.6)	5.1 (1.3)	6.5 (0.6)	2.3 (0.8)	5.4 (1.4)

Note: Ratings are on a scale of 1 (low) to 7 (high).

Table 3

Experiment 2: Recall Estimates as a Function of Approach and Avoidance Ratings

	Young Adults		Older Adults	
	High Approach	Low Approach	High Approach	Low Approach
High Avoid	.29	.38	.28	.32
Low Avoid	.36	.23	.30	.36

Note: Estimates were calculated at ± 1 *SD* from the mean for each type of rating.