Published in final edited form as:

Neuropsychol Dev Cogn B Aging Neuropsychol Cogn. 2008 November ; 15(6): 725–743. doi:
10.1080/13825580802348562.

Are Preferences in Emotional Processing Affected by Distraction? Examining the Age-Related Positivity Effect in Visual Fixation Within a Dual-Task Paradigm

Eric S. Allard and Derek M. Isaacowitz

Department of Psychology, Brandeis University, Waltham, Massachusetts

Abstract

Recent research has suggested that age-related positivity effects are eliminated under conditions of dual-task load (Knight et al., 2007; Mather & Knight, 2005), because the cognitive control resources necessary to enact such preferences are not available when individuals are distracted by competing information. We further examined how older adults' emotional information processing preferences are affected by distracting information by utilizing a within-subjects dual-task measure. Younger and older adults viewed a series of positive, negative, and neutral images both in conditions of full and divided attention. Fixation preferences to valenced images were assessed through eye tracking. Regardless of whether images were viewed in full or divided attention conditions, older adults demonstrated a preference in their fixation for positive and neutral in comparison to negative images. These results provide evidence that older adults' positive fixation preferences may not always necessitate full, cognitive control.

Despite well-known decrements in a variety of cognitive abilities (Craik, 1983; Craik & Byrd, 1982; Stoltzfus, Hasher, & Zacks, 1996), health, and physical functioning (Beckett et al., 1996; Fried et al., 2001), older adults' emotional lives appear positive (Carstensen & Charles, 1998; Carstensen, Pasupathi, & Mayr, & Nesselroade, 2000). Older adults report greater emotional control, mood stability, emotional maturity (Lawton, Kleban, & Rajagopal, 1992), and may be happier than younger adults (Mroczek & Kolarz, 1998). Socioemotional Selectivity Theory (Carstensen, Isaacowitz, & Charles, 1999) contends that older adults' positive emotional functioning may be facilitated by a focus on emotion regulation goals due to a limited time perspective. Constraints on one's future time likely promotes a focus on goals that will be of service in the present, such as feeling good and being happy. Recent research has suggested that older adults' motivation to elicit or enhance a positive affective state may be reflected in their emotional information processing preferences (Carstensen, Mikels, & Mather, 2006).

One way that emotion regulatory goals might impact older adults' information processing is through a focus on positive and/or a disengagement from negative emotional material; this has been termed a "positivity effect" (Carstensen & Mikels, 2005; Mikels, Larkin, Reuter-Lorenz, & Carstensen, 2005). Age-related positivity effects have been observed in assessments of both attention and memory (cf., Murphy & Isaacowitz, 2008). With regards to memory, older adults have been shown to be more forgetful of negative images (Charles, Mather, & Carstensen, 2003), more positive in recalling past life events (Kennedy, Mather, & Carstensen, 2004), and to remember more positive information in certain working memory tasks (Mikels et al.,

2005). Older adults, in comparison to younger adults, have also demonstrated preferences in visual attention toward positive and away from negative emotional images (Isaacowitz, Wadlinger, Goren, & Wilson, 2006; Mather & Carstensen, 2003).

At the same time, a reliable decline in cognitive abilities with advanced age (e.g., Craik, Anderson, Kerr, & Li, 1995) brings up the question as to whether age-related positivity effects require concerted effort in order to be enacted. What role does controlled processing play in older adults' preferences for positive and/or avoidance of negative emotional information in light of their declining cognitive abilities? One way to address this question is to examine how older adults process emotional stimuli in a cognitively demanding situation, such as a dual-task or divided attention scenario. This design strategy provides a means for assessing the amount of resource allocation, or controlled effort, necessary for older adults to display positivity effects when being distracted by a competing task (see Knight, Seymour, Gaunt, Baker, Nesmith, & Mather, 2007; Mather & Knight, 2005).

Positivity Effects and Divided Attention

There have been relatively few studies that have examined how age-related positivity effects are affected by dual-task constraints. Results have been mixed as to whether positive emotional processing preferences necessitate controlled effort in the presence of competing and distracting information. Some work has suggested that controlled processing may be necessary for such preferences to emerge. Mather & Knight (2005) found that older adults remembered a higher proportion of positive relative to negative images compared to younger adults when a distracter was not present. However, when attention was divided by a competing auditory task at memory encoding, older adults actually remembered a higher proportion of negative relative to positive images. A similar pattern of results were found in a recent eye tracking study by Knight et al. (2007) in which a group of older adults viewing emotionally-valenced images in a full attention condition fixated more toward positive images, while older adults in a divided attention condition fixated more toward negative images. The reversal of the positivity effect in the divided attention conditions of these two studies was interpreted as evidence that controlled processing is necessary for older adults to exert motivated preferences toward positive stimuli. In other words, when cognitive resources are not available, a motivated focus on the positive is not possible and older adults may revert to a more stimulus-driven focus on the negative.

Other studies have shown that older adults demonstrate a more automatic prioritization of negative emotional information in certain contexts. For instance, Hahn, Carlson, Singer, & Gronlund (2006) found that older adults, similar to younger adults, were quicker at detecting an angry face rather than happy face targets amongst an array of nonemotional distracters. Relatedly, Mather & Knight (2006) also found older adults to be faster at locating angry relative to happy and sad face targets when presented with neutral distracter faces. Automatic vigilance toward negative (particularly threatening) information should be highly adaptive for older adults. Once negative stimuli are detected, cognitive control resources can be recruited in order to effectively avoid information that would be detrimental to a positive affective state. However, when cognitive control resources are constrained—as is the case during dual-task processing—top-down influences may be ineffective in overriding the automatic saliency of negative information (Mather & Knight, 2005).

In contrast to these studies showing an elimination (or reversal) of age-related positivity effects when attention is divided, one recent study has shown that preferences in memory for positive stimuli can be maintained for older adults in certain dual-task situations. Thomas & Hasher (2006) found that when younger and older adults viewed a series of emotionally-valenced words while simultaneously performing a visual, numerical target discrimination task, older

adults remembered a higher proportion of positive relative to negative words. This finding suggests that motivational effects on processing may not always necessitate full cognitive control.

Given the inconsistencies in these recent findings, questions arise as to how dual-task performance is measured. Apart from discrepancies in the tasks and stimuli used, it is notable that research attention has not been given to investigating divided attention performance using a within-subjects method. In the aforementioned divided attention studies, dual-task performance was assessed between-subjects. One advantage of utilizing a within-subjects design is that it allows for comparisons as to how individuals perform on an emotional processing task, without distraction, in comparison to their own performance when attention is divided. Furthermore, we can specifically examine whether dividing one's attention incurs processing costs, namely costs in positive emotional processing preferences for older adults. This framework has been implemented in a number of studies for investigating potential age differences in divided attention performance on non-emotional tasks (e.g., Anderson, Craik, & Naveh-Benjamin, 1998; Naveh-Benjamin, Craik, Guez, & Krueger, 2005; Whiting, 2003). This design strategy may be promising for disentangling when, and why, there are changes in older adults' positive emotional preferences in dual-task conditions.

Current Study

The present study utilized a within-subjects framework to examine the effects of dual-task constraints on older adults' visual processing of emotional stimuli. Both younger and older adults viewed a series of positive, negative, and neutral images in conditions of full attention and when attention was divided by an auditory, lexical decision task. Eye tracking was used to assess potential age-related differences in gaze preferences to valenced images as a function of the presence and absence of distraction imposed by a secondary task.

With research indicating an age-related positivity effect in assessments of both visual attention (Isaacowitz et al., 2006; Mather & Carstensen, 2003) and other modes of processing such as memory (Charles, Mather, & Carstensen, 2003; Kennedy, Mather, & Carstensen, 2004; Mikels et al., 2005) in various single-task scenarios, we hypothesized that older adults would demonstrate a fixation preference for positive relative to negative and neutral images when performance was assessed in full attention. However, given evidence from some studies that older adults do not seem to show a preference in their attention (Knight et al., 2007) and memory (Mather & Knight, 2005) for positive images when attention is divided, we expected older adults not to show a preference in their fixation for positive relative to negative or neutral images in the divided attention condition. We assumed that cognitive control processes would be compromised to the extent that older adults would not be able to demonstrate a preference in their visual fixation for positive stimuli. We did not expect younger adults to be influenced by motivations to utilize attentional strategies to optimize their positive affect, and given research indicating that younger adults tend to place more weight on processing negative relative to positive information (Baumeister, Bratslavsky, Fickener, & Vohs, 2001; Rozin & Rozyman, 2001), we hypothesized that younger adults, regardless of condition, would display greater fixation preferences toward negative rather than positive and neutral images.

Method

Participants

Twenty young (4 males, 16 females; ages 18-30, $M = 21.60$, $SD = 3.34$) and 20 older (6 males, 14 females; ages 60-89, $M = 70.45$, $SD = 8.27$) adults served as participants for the current study. Younger adults were recruited from the Introductory Psychology subject pool and the general student population at Brandeis University. Older adults were recruited via participant

databases affiliated with our laboratory and through electronic and print media advertisements. All participants were offered either a monetary stipend or one class credit toward meeting a course requirement. Participants were excluded from the eye tracking analyses if they wore hard contacts or displayed other eye abnormalities (i.e. reflective eyewear, small pupil diameter, pupil obfuscation) that rendered data unreadable to the eye tracker. One younger adult, and 4 older adult participants, were untrackable based on these criteria, leaving 95% (19) of the younger and 80% (16) of the older adult samples available for the eye tracking analyses. Trackable older adults had significantly higher far visual acuity, $t(18) = 2.27, p < .05$, and marginally greater near visual acuity, $t(18) = 1.99, p < .07$, in comparison to the non-trackable older adults. No other differences emerged between trackable and untrackable participants in either age group.

Stimuli

Emotional images for the eye tracking tasks were positive, neutral, and negatively valenced pictures taken from the International Affective Picture System database (IAPS: Lang, Bradley, & Cuthbert, 2001). Lang et al. compiled normed image ratings from young adult participants on a scale from 1 (high *negative valence/low arousal*) to 9 (high *positive valence/high arousal*). In order to alleviate confounds of arousal on attention for the images, regardless of valence, both positive and negative images were matched on arousal (positive: $M = 4.54, SD = .28$; negative: $M = 4.63, SD = .40, p = .40$). Additionally, valence ratings between positive and negative images were of equal intensity in comparison to the neutral images used (i.e. differences in ratings between positive and neutral images were equal to differences in ratings between negative and neutral images; positive: $M = 7.35, SD = .51$; negative: $M = 3.06, SD = .49$; neutral: $M = 5.36, SD = .53$). A paired-samples t -test indicated that intensity ratings, as calculated from difference scores between positive-neutral and negative-neutral valence ratings, did not differ significantly from each other ($p = .31$).

A total of 72 images (24 positive, 24 negative, and 24 neutral) were used for the current study. Each eye tracking task was comprised of 24 images (8 positive, 8 negative, 8 neutral). Images were selected and appeared in random order within each condition. A list of the IAPS images used (denoted by IAPS image number) can be found in Appendix A.

The secondary task for the divided attention condition involved making a lexical judgment (word versus non-word) to an emotionally-neutral, auditory stimulus. A lexical decision task was used, following research indicating that word/non-word judgments can provide an adequate level of cognitive load in certain dual-task contexts (McCann, Remington, & Van Selst, 2000). Words were taken from the Affective Norms for English Words database (ANEW: Bradley & Lang, 1999). Bradley and Lang compiled normed word ratings from young adult participants on a scale from 1 (high *negative valence/low arousal*) to 9 (high *positive valence/high arousal*). We randomly selected 24 words out of a pre-selected series of 72 neutral words. Half of the neutral words were manipulated into non-words by changing the first or second syllable consonant sound or by placing a consonant sound at the beginning of the word (i.e. *fabric* becomes *mabric*, *lantern* becomes *langern*, and *alley* becomes *nalley*). Of the 12 manipulated non-words, 9 were manipulated by changing the first syllable sound, 1 was manipulated by changing the second syllable sound, and 2 words were manipulated by adding a consonant sound to the beginning of the word; this was similar to Mechelli et al. (2003)'s procedure for creating non-words from real, English words. The experimenter's voice was used to record the neutral word lists. A list of the neutral words and non-words used can be found in Appendix B.

Equipment and Procedure

The eye tracking apparatus was an Applied Science Laboratories (ASL) Eye Tracker Model 504 with Magnetic Head Transmitter. The eye tracker records the position of the participant's left eye gaze 60 times per second during the entire duration of a visual stimulus presentation. The dependent variable of interest is fixation percentage. Fixation percentage is defined as the amount of time a participant's gaze fixates on a predetermined area of interest (AOI) in comparison to the amount of time the participant is fixated anywhere on the screen. Fixations are defined as the participant's gaze oriented to within one degree visual angle of a particular point on the screen for at least 100 ms (Manor & Gordon, 2003). GazeTracker software was used to automate and record the appearance and duration of the visual stimuli, gaze and fixations to the stimuli, and behavioral responses to the distracter task. Absolute Sound Recorder software was used for initial recording and presentation of the word lists.

Prior to the eye tracking session, a series of demographic, mood, personality, and cognitive measures were administered, and data related to performance on these measures can be found in Table 1¹. For the eye tracking portion of the experiment, participants were seated in front of a 15-inch computer monitor. The eye tracker camera was placed below the computer monitor, at a distance of 42 in. from the participants left eye, while image viewing occurred at a distance of 35 in. Each stimulus image during the eye tracking task appeared in a central location on the screen and encompassed an area of 676×507 pixels. Image AOIs included the central emotional element(s) of each image. The average dimensions of image AOIs were as follows: positive (560.44×464.57), negative (541.50×430.63), and neutral (634.38×501.13). Neutral AOIs were slightly larger given that the neutral content tended to include a more substantial portion of the area within those images. A 17-point eye calibration procedure was performed in order to make sure that the eye tracker was accurately capturing each participant's left pupil position to all points on the computer screen. Participants were instructed to shift their gaze to 17 points on the computer screen while the experimenter stored each position to within one degree visual angle of each predetermined point.

The first viewing task was performed in full attention. Participants viewed 24 slides in which 8 positive, 8 negative, and 8 neutral pictures appeared on a gray background, one per slide, for 2 s each. Each picture was followed by a 4 s ISI (blank, gray screen). Participants were instructed to view the images, naturally, as if they were at home watching television (see Isaacowitz et al., 2006). Participants next viewed a new series of images in the divided attention condition. A new series of 24 slides (equal across valence) was presented. In addition, a word/non-word was presented over a set of speakers at the beginning of each 2 s slide presentation trial. Participants were instructed to make a key response indicating whether or not what they heard was a word or a non-word ("V" for word, "N" for non-word) as quickly as possible. Participants were asked to continue to view the images much like they had before in the previous condition. Finally, participants were instructed to view a new series of 24 slides (equal

¹A series of demographic, vision, affective, and cognitive measures were used as sample comparisons between our younger and older adults. A single-item, self-reported health rating was administered on a scale from 1 (poor) – 5 (excellent). Far-visual acuity was measured with the Snellen 20/20 E-chart (lower scores indicate better acuity), near-visual acuity was measured with the Rosenbaum Near-Vision scale (lower scores indicate better acuity), and contrast sensitivity was measured with the Pelli-Robson scale (higher scores indicate better sensitivity).

Scores on the Future Time Perspective Scale (FTP) could range from 10 to 70 with higher scores indicating a more expansive future. Scores on the trait optimism measure (Life Orientation Test; LOT) ranged from 0 – 48 with higher scores indicating greater optimism. The range of scores on the Center for Epidemiological Studies – Depression scale (CES-D) were from 0 – 60 with higher scores indicating greater depressive symptomatology. Scores on the subscales of the PANAS could range from 10 – 50 with higher scores indicating greater positive or negative affect.

The Mini-Mental Status Examination was used to screen for possible symptoms of dementia amongst our older adult participants; scores could range from 0 – 30. The Shipley Vocabulary test was used to measure crystallized abilities, and the range of scores were from 0 – 20. The digit span (forward and back) were used to examine fluid intelligence; scores on the forward-span could range from 0 – 9 while scores on the backward-span could range from 0 – 8. Finally, the executive functioning subset of the Attentional Network Test (ANT) was used to assess executive control. Lower scores indicate better executive control.

across valence) for a second viewing in full attention². Participants were given the same viewing instructions as the first full attention condition, with images appearing for the same time duration. The experimental session lasted between 60-90 minutes.

Results

Secondary Task Performance

Accuracy rates for the lexical decision task were high for both younger and older adults. Young adults made accurate judgments on 94% of the trials, while older adults made accurate judgments on 91% of the trials. Response accuracy did not differ significantly across age ($p = .34$).

Fixation Patterns

We first addressed potential order effects in fixation among our two full attention conditions across age and image valence. An initial repeated measures ANOVA found no significant main effect of full attention condition (first vs. second) and no significant interactions with age or image valence. Therefore, we collapsed our data across these two full attention conditions. For the main analyses, a $2 \times 2 \times 3$ repeated measures ANOVA was conducted with Age (young, old) as a between-subjects factor and Condition (full attention-combined, divided attention) and image Valence (positive, negative, neutral) as within-subjects factors. A main effect of Condition, $F(1, 32) = 5.11, p < .05, \eta_p^2 = .14$, emerged whereby fixation percentages were higher in the divided attention condition ($M = 90.30, SE = 1.44$) in comparison to the full attention conditions ($M = 87.03, SE = 1.48$). Additionally, a significant main effect of Valence, $F(1, 32) = 48.40, p < .001, \eta_p^2 = .60$, was indicated by higher fixation percentages for neutral ($M = 93.43, SE = 1.13$) in comparison to positive ($M = 89.42, SE = 1.20$) images and for positive in comparison to negative ($M = 83.13, SE = 1.79$) images. Finally, a significant Age $\times$ Condition $\times$ Valence interaction, $F(2, 64) = 4.32, p < .05, \eta_p^2 = .12$, also emerged.

In order to deconstruct the significant three-way interaction, we used within-group t -tests to examine fixation patterns separately for each age group across condition and valence type. As shown in Figure 1, older adults fixated more toward neutral, $t(15) = 3.94, p < .01$, and positive, $t(15) = 2.84, p < .05$, in comparison to negative images in the full attention conditions. This same pattern of results was found in the divided attention condition, whereby older adults fixated more toward neutral, $t(14) = 5.02, p < .001$, and positive, $t(14) = 2.67, p < .05$, in comparison to negative images. To determine whether there were any costs in fixation for any valence type when attention was divided, we analyzed difference scores in fixation percentage between the full and divided attention conditions. We found that older adults did not demonstrate a significant change in fixation preference for any valence type: positive cost ($M = -.63, SD = 11.24, p = .8$), negative cost ($M = 1.86, SD = 14.68, p = .6$), neutral cost ($M = -2.61, SD = 11.60, p = .4$). Together, these results indicate that, contrary to our hypotheses, older adults demonstrated a positivity effect in their fixation as evidenced by a greater fixation preference for positive relative to negative images regardless of whether the images were viewed in full or divided attention.

Younger adults demonstrated higher fixation percentages for neutral in comparison to positive, $t(19) = 3.95, p < .01$, and for positive in comparison to negative, $t(19) = 3.09, p < .01$, images in the full attention conditions. In the divided attention condition, younger adults fixated more toward neutral in comparison to negative images, $t(18) = 2.71, p < .05$. In examining fixation

²A second full attention condition was included in order to bolster our within-subjects assessment of whether older adults' fixation preferences do change as a function of dual-task constraint. This condition allowed us to investigate whether older adults' hypothesized fixation preferences toward positive images would return when given the opportunity to perform an additional viewing task without distraction.

costs from full to divided attention, we found that younger adults actually fixated more, not less, toward positive ($M = -7.60$, $SD = 8.86$), $t(18) = 3.74$, $p < .01$, and negative ($M = -10.17$, $SD = 13.46$), $t(18) = 3.30$, $p < .01$, images in the divided attention condition in comparison to the full attention conditions.

In between-group analyses across valence type within each condition, we only found age differences in fixation percentages in the divided attention condition. Younger adults demonstrated greater fixation percentages to both positive, $t(32) = 2.64$, $p < .05$, and negative, $t(32) = 2.92$, $p < .01$, images in comparison to older adults.

Discussion

The present study investigated whether age-related positivity effects in fixation are affected by dual-task constraints. We attempted to extend beyond the relatively few studies that have observed older adults' emotional information processing preferences to either be maintained (Thomas & Hasher, 2006) or reversed (Knight et al., 2007; Mather & Knight, 2005) in certain divided attention conditions. Unlike these recent studies, we utilized a within-subjects dual-task paradigm in order to assess whether a change in fixation preference (a "cost") occurs when comparing participant's own fixation patterns in both full and divided attention.

Preservation of Positivity Effects under Dual-Task Load

In full attention, a positivity effect emerged whereby older adults displayed higher fixation percentages toward positive relative to negative images, though we found that older adults did not differ in their fixation between positive and neutral images. Contrary to our hypotheses, we found that older adults maintained a fixation preference for positive over negative images in the divided attention condition. These results, consistent with memory findings from Thomas & Hasher (2006), suggest that positivity effects *can* emerge in older adults' processing despite the presence of competing task demands.

These results are also in line with recent research indicating that top-down influences on information processing can be somewhat resilient to a variety of cognitive control constraints in old age. Madden and colleagues (Madden 2007; Madden Whiting, Cabeza, & Huettel, 2004; Madden, Whiting, Spaniol, & Bucur, 2005) have shown that top-down influences can be helpful in promoting rapid and efficient performance on complex visual search tasks for older adults. For instance, older adults are able to utilize knowledge of target expectancies to alleviate distraction from competing stimuli. Using top-down information to avoid bottom-up attentional capture from irrelevant distracters allows for a more "automatic" detection of the task-goal target. Additionally, Germain and Hess (2007) have shown that cognitive control constraints have less of an impact in situations where older adults process information that is motivationally self-relevant. In this study, younger and older adults read a series of age-matched relevant and irrelevant passages, and cognitive control constraints were employed by embedding distracting, irrelevant text within the passages. When passages were highly self-relevant, older adults were able to read the passages faster, were better at comprehending the relevant text, and showed poorer recall for distracting words in comparison to when the passages were not self-relevant. It would seem that a motivation to process self-relevant passages was quite successful in spite of the increased cognitive load elicited by the distracting text. Taken together with our results, there is a suggestion that motivated information processes can be displayed by older adults in many contexts and thus may not necessitate full cognitive control.

Why, then, have other studies observed a reversal of older adults' motivated gaze preferences for positive stimuli (e.g. Knight et al., 2007) under dual-task constraints? Our contrasting findings from those of Knight et al. could be due, in part, to certain methodological distinctions.

Specifically, there are some noticeable differences with regard to how visual fixation was measured and the type and amount of distraction levied by the secondary tasks in the two studies. With regard to fixation, we utilized a measure that takes into account relative fixation duration to a specific area of interest in comparison to time spent fixated anywhere else on the screen. In contrast, Knight et al. analyzed the proportional number of fixations made separately to two images (emotional-emotional and emotional-neutral pairs), without describing the relative duration of those fixations. One issue with only examining the total number of fixations is the possibility that, although an individual may make more fixations to a particular area(s) of interest, those fixations may be relatively short in comparison to the fewer but longer fixations made elsewhere. A measure of percent fixation duration will account for the total number of fixations made, as well as indicate whether an individual is actually spending more time attending to a particular image or area of interest.

A more substantive possibility for the discrepant results between the current study and the Knight et al. (2007) study involves differences in the level of demand and distraction incurred by the respective secondary tasks. In the present study, an auditory word/non-word judgment was presented very briefly at the very beginning of a short, 2 s image presentation trial in the divided attention condition. This, perhaps, provided a situation of minimal distraction for older adults, and they were thus able to maintain their positive emotional information processing preferences. However, Knight et al. (2007) presented their distracter (persistent auditory tone) during the entire 6 s that image pairs were displayed. Therefore, it is possible that a reversal of the positivity effect for older adults in that study could be due to longer and more consistent demands being placed on cognitive control abilities (Lavie, 2004). It is plausible that positivity effects can be displayed by older adults at low levels of distraction but not at higher levels, suggesting that such effects require some rather than full cognitive control.

Related to the idea that positivity effects in fixation may not necessitate a high level of cognitive control, we recently examined potential cognitive correlates and time course of older adults' gaze preferences toward positive stimuli (Isaacowitz, Allard, Murphy, & Schlangel, in press). We found that older adults' fixation preferences emerged early, but not immediately in processing (between 500-1000 ms after the onset of the stimuli). This would indicate that some time is necessary for these preferences to occur, which would be consistent with the idea that some amount of top-down/cognitive control ability is required. However, we did not find these early fixation patterns to be significantly related to any of our cognitive measures, including ones that assessed executive functioning and cognitive control ability. This would again suggest that older adults may not need *all* of their available cognitive control resources in order to enact positive emotional processing preferences.

Young Adult Fixation Patterns

Contrary to our hypotheses, younger adults tended not to show a greater preference for negative relative to positive and neutral images, regardless of condition. Although these results were somewhat unexpected given theoretical work on negativity biases (Baumeister et al., 2001; Rozin & Rozyman, 2001), there is research to suggest that negative information will not always be preferred over positive in certain contexts. For instance, positive mood states can elicit preferential processing of positive information (Wegener & Petty, 1994). Additionally, preferential processing of negative information can be attenuated for individuals who have low levels of dysphoric symptoms (Caseras, Garner, Bradley, & Mogg, 2007), are generally optimistic (Isaacowitz, 2005), and are primed into positive affective contexts (Smith, Larsen, Chartrand, Cacioppo, Katafiasz, & Moran, 2006). To investigate whether mood or personality characteristics could potentially account for why we did not observe any negativity effects in the younger adults, we analyzed correlations between our fixation measures and a variety of self-report measures that assessed positive and negative affect, depressive symptoms, and

optimism. However, we did not find gaze to be significantly related to any of these measures, indicating that younger adult fixation patterns are not necessarily due to a positive affective profile, at least to the extent that such measures were assessed in the current study.

A more plausible possibility for why we did not observe a negativity effect in younger adults' gaze could be related to characteristics of our stimuli. Previous research that has observed these negativity effects have done so by using extremely negative and arousing stimuli (Rozin & Rozyman, 2001; Cacioppo, Gardner, & Berntson, 1997; Ito, Larsen, Smith, & Cacioppo, 1998). Highly arousing and negative stimuli likely necessitate more immediate engagement and action than would be necessary for positive stimuli. We used positive and negative IAPS images that did not differ significantly on normed ratings of arousal, which may have diminished the immediate saliency of our negative images above and beyond that of the positive images. This idea is further supported by a recent study in our lab that utilized equally-arousing positive and negative IAPS images. When a subsample of younger adults were asked to view images in a way similar to participants in the current study (i.e. look naturally at the images as if watching television), fixation percentages were greater for positive relative to negative images (Xing & Isaacowitz, 2006). Therefore, it may be more likely that negativity effects emerge for younger adults in situations where they are confronted with rather potent and extreme negative stimuli.

In addition to our inability to detect a negativity effect in younger adult gaze patterns, we were also surprised to find an increase, rather than a decrease, in fixation percentages to emotional images in the divided attention condition for younger adults. One possibility for these results could be that given the anticipated distraction by the secondary task, younger adults may have been trying to enhance their vigilance toward the eye tracking task. While increases in fixation were only found in response to positive and negative images, this should not be too surprising given that fixation percentages for the neutral images in the full attention condition were already close to ceiling. Younger adult attempts to maximize performance on the eye tracking task may also help explain why age differences in gaze patterns were observed in the divided attention condition. While younger adults may have attempted to maximize their gaze toward all image types in response to the secondary task, older adults appeared to be best able to maintain a comparable fixation pattern (within each emotion type) in the divided relative to the full attention condition.

Limitations and Future Directions

One limitation of the current study was the relatively small sample size used. This brings up questions as to whether an adequate level of power has been achieved to examine group differences in fixation preference. While the sample size in this study was on the low end of the range of previous eye tracking studies of age and emotional processing (e.g. Isaacowitz et al., 2006a, 2006b), our use of a within-subjects design may alleviate sample size concerns. An additional limitation could be the larger AOI sizes of the neutral as compared to the positive and negative images. However, this small difference should have no bearing on the critical gaze comparisons between positive and negative images, which had AOI dimensions of the same size.

Both younger and older adults demonstrated high accuracy rates on the secondary lexical decision task—even in the divided attention condition, suggesting that the lexical judgments themselves seemed to be of minimal difficulty. Recent work has shown that older adults can perform quite proficiently on certain lexical decision tasks under dual-task load (Lien et al., 2006). It is possible that older adults were able to maintain their fixation preference for positive relative to negative images due to the relative ease of the secondary task. However, it is still notable that older adults were able to demonstrate positivity effects in their fixation even with low levels of distraction.

Despite these limitations, results from the current study do suggest that older adults' ability to display positive preferences in their fixation may not always be affected by cognitive control constraints. This was indicated by older adults demonstrating a greater preference in their gaze for positive relative to negative images in conditions of both full and divided attention. More work is needed to better determine whether age-related motivational influences on cognition, such as those posited by socioemotional selectivity theory, can be maintained under varying levels of demand on cognitive control resources. Assessing older adults' emotional information processing preferences under a variety of distracting conditions will hopefully improve our understanding as to just how much cognitive control is required for goal-relevant processing to occur. For instance, it could be the case that older adults are able to resist low levels of distraction when processing emotionally salient information but find it difficult to focus on achieving emotional goals when distraction is high. Varying the type and amount of competing task demands within the same study could better elucidate whether there is a threshold such that older adults can maintain their emotional processing preferences under cognitive constraint on one side of the threshold but not the other. To the extent that such a threshold can be identified, older adults may be well-served pursuing their emotional goals by selecting situations with minimal distraction.

Appendix A

IAPS Numbers for Emotional Images

Positive

2030, 2092, 2222, 2260, 2311, 2340, 2375, 2392, 2395, 2550, 2650, 8162, 8461, 1340, 1440, 1463, 1510, 1721, 1750, 5594, 5849, 7200, 7282, 7470

Negative

2141, 2455, 2490, 2750, 2900, 3300, 6311, 9415, 9041, 9046, 9560, 9584, 9912, 1270, 7361, 9010, 9102, 9101, 9110, 9280, 9440, 9471, 9561, 9830

Neutral

1616, 1670, 1935, 1947, 2372, 2214, 2221, 2394, 2485, 2487, 2515, 5875, 5900, 2880, 6930, 5390, 7009, 7034, 7036, 7140, 7503, 7560, 8211, 8311

Appendix B

Neutral ANEW Word and Non-Word Derivatives for the Secondary Task

Words: statue, cane, clock, army, rain, vest, white, finger, phase, highway, bathroom, knot

Non-Words: flass (glass), opey (obey), langern (lantern), randage (bandage), mabric (fabric), nuilnding (building), preet (street), lillage (village), gug (jug), nalley (alley), sarm (arm), sork (fork)

Acknowledgements

Preparation of this manuscript was supported by a National Institute on Aging grant RO1 AG026323 to DMI. The authors would like to thank Angela Gutches for her helpful suggestions on earlier versions of this project.

References

- Anderson ND, Craik FIM, Naveh-Benjamin M. The attentional demands of encoding and retrieval in younger and older adults: 1. Evidence from divided attention costs. *Psychology and Aging* 1998;13:405–423. [PubMed: 9793117]
- Beckett LA, Brock DB, Lemke JH, Mendes de Leon CF, Guralnik JM, Fillenbaum CG. Analysis of change in self-reported physical function among older persons in four population studies. *American Journal of Epidemiology* 1996;143:766–778. [PubMed: 8610686]
- Baumeister RF, Bratslavsky E, Fickenaue C, Vohs KD. Bad is stronger than good. *Review of General Psychology* 2001;5:323–370.
- Bradley, MM.; Lang, PJ. Affective norms for English words (ANEW): Instruction manual and affective ratings. The Center for Research in Psychophysiology, University of Florida; 1999. Technical Report C-1
- Cacioppo JT, Gardner WL, Berntson GG. Beyond bipolar conceptualizations and measures: The case of attitudes and evaluative space. *Personality and Social Psychology Review* 1997;1:3–25. [PubMed: 15647126]
- Carstensen LL, Charles ST. Emotion in the second half of life. *Current Directions in Psychological Science* 1998;7:144–149.
- Carstensen LL, Isaacowitz DM, Charles ST. Taking time seriously: A theory of socioemotional selectivity. *American Psychologist* 1999;54:165–181. [PubMed: 10199217]
- Carstensen, LL.; Lang, FR. Future Orientation Scale. Stanford University; 1996. Unpublished manuscript
- Carstensen LL, Mikels JA. At the intersection of emotion and cognition: Aging and the positivity effect. *Current Directions in Psychological Science* 2005;14:117–121.
- Carstensen, LL.; Mikels, JA.; Mather, M. Aging and the intersection of cognition, motivation, and emotion. In: Birren, JE.; Schaie, KW., editors. *Handbook of the psychology of aging*. Vol. 6. Amsterdam, The Netherlands: Elsevier; 2006. p. 343–362.
- Carstensen LL, Pasupathi M, Mayr U, Nesselroade JR. Emotional experience in everyday life across the adult life span. *Journal of Personality and Social Psychology* 2000;79:644–655. [PubMed: 11045744]
- Caseras X, Garner M, Bradley BP, Mogg K. Biases in visual orienting to negative and positive scenes in dysphoria: An eye movement study. *Journal of Abnormal Psychology* 2007;116:491–497. [PubMed: 17696705]
- Charles ST, Mather M, Carstensen LL. Aging and emotional memory: The forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General* 2003;132:310–324. [PubMed: 12825643]
- Craik FIM. On the transfer of attention from temporary to permanent memory. *Philosophical Transactions of the Royal Society of London* 1983;Series, B302:341–359.
- Craik, FIM.; Anderson, ND.; Kerr, SA.; Li, KZH. Memory changes in normal aging. In: Baddeley, AD.; Wilson, BA.; Watts, FN., editors. *Handbook of memory disorders*. Chichester, England: Wiley; 1995. p. 211–241.
- Craik, FIM.; Byrd, M. Aging and cognitive decline: The role of attentional resources. In: Craik, FIM.; Trehub, S., editors. *Aging and cognitive processes*. New York: Pelnum; 1982. p. 191–211.
- Fan J, McCandliss BD, Sommer T, Raz A, Posner MI. Testing the efficiency and independence of attentional networks. *Journal of Cognitive Neuroscience* 2002;14:340–347. [PubMed: 11970796]
- Folstein MF, Folstein SE, McHugh PR. “Mini-mental state”: A practical method for grading the cognitive state of patients for clinician. *Journal of Psychiatric Research* 1975;12:189–198. [PubMed: 1202204]
- Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: Evidence for a phenotype. *The Journals of Gerontology Series A, Biological Sciences and Medical Sciences* 2001;56:M146–M156.
- Germain CM, Hess TM. Motivational influences on controlled processing: Moderating distractibility in older adults. *Aging, Neuropsychology, and Cognition* 2007;14:462–486.
- Hahn S, Carlson C, Singer S, Gronlund SD. Aging and visual search: Automatic and controlled attentional bias to threat faces. *Acta Psychologica* 2006;123:312–336. [PubMed: 16524554]
- Isaacowitz DM. The gaze of the optimist. *Personality and Social Psychology Bulletin* 2005;3:407–415. [PubMed: 15657455]

- Isaacowitz DM, Allard ES, Murphy NA, Schlangel M. Unraveling age-related gaze preferences to positive stimuli: Time course and correlates. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*. in press
- Isaacowitz DM, Wadlinger HA, Goren D, Wilson HR. Is there an age-related positivity effect in visual attention? A comparison of two methodologies. *Emotion* 2006a;6:511–516. [PubMed: 16938091]
- Isaacowitz DM, Wadlinger HA, Goren D, Wilson HR. Selective preference in visual fixation away from negative images in old age? An eye tracking study. *Psychology and Aging* 2006b;21:40–48. [PubMed: 16594790]
- Ito TA, Larsen JT, Smith K, Cacioppo JT. Negative information weighs more heavily on the brain: The negativity bias in evaluative categorizations. *Journal of Personality and Social Psychology* 1998;75:887–900. [PubMed: 9825526]
- Kennedy Q, Mather M, Carstensen LL. The role of motivation in the age-related positivity effect in autobiographical memory. *Psychological Science* 2004;15:208–214. [PubMed: 15016294]
- Knight M, Seymour TL, Gaunt JT, Baker C, Nesmith K, Mather M. Aging and goal directed emotional attention: Distraction reverses emotional biases. *Emotion* 2007;7:705–714. [PubMed: 18039037]
- Lang, P.J.; Bradley, M.M.; Cuthbert, B. International affective picture system (IAPS): Technical manual and affective ratings. The Center for Research in Psychophysiology, University of Florida; 1999.
- Lavie N. Distracted and confused?: Selective attention under load. *Trends in Cognitive Sciences* 2004;9:75–82. [PubMed: 15668100]
- Lawton MP, Kleban MH, Rajagopal D. Dimensions of affective experience in three age groups. *Psychology and Aging* 1992;7:171–184. [PubMed: 1610505]
- Lien MC, Allen PA, Ruthruff E, Grabbe J, McCann RS, Remington RW. Visual word recognition without central attention: Evidence for greater automaticity with advancing age. *Psychology and Aging* 2006;21:431–447. [PubMed: 16953708]
- Madden DJ. Aging and visual attention. *Current Directions in Psychological Science* 2007;16:70–74. [PubMed: 18080001]
- Madden DJ, Whiting WL, Cabeza R, Huettel. Age-related preservation of top-down attentional guidance during visual search. *Psychology and Aging* 2004;19:304–309. [PubMed: 15222823]
- Madden DJ, Whiting WL, Spaniol J, Bucur B. Adult age differences in implicit and explicit components of top-down attentional guidance during visual search. *Psychology and Aging* 2005;20:317–329. [PubMed: 16029095]
- Manor BR, Gordon E. Defining the temporal threshold for ocular fixation in free-viewing visuocognitive tasks. *Journal of Neuroscience Methods* 2003;128:85–93. [PubMed: 12948551]
- Mather M, Carstensen LL. Aging and attentional biases for emotional faces. *Psychological Science* 2003;14:409–415. [PubMed: 12930469]
- Mather M, Knight M. Goal directed memory: The Role of cognitive control in older adults' emotional memory. *Psychology and Aging* 2005;20:554–570. [PubMed: 16420131]
- Mather M, Knight M. Angry faces get noticed quickly: Threat detection is not impaired among older adults. *Journal of Gerontology: Psychological Sciences* 2006;61B:P54–P57.
- McCann RS, Remington RW, Van Selst M. A dual-task investigation of automaticity in visual word processing. *Journal of Experimental Psychology: Human Perception and Performance* 2000;26:1352–1370. [PubMed: 10946719]
- Mechelli A, Gorno-Tempini ML, Price CJ. Neuroimaging studies of word and pseudoword reading: Consistencies, inconsistencies, and limitations. *Journal of Cognitive Neuroscience* 2003;15:260–271. [PubMed: 12676063]
- Mikels JA, Larkin CR, Reuter-Lorenz PA, Carstensen LL. Divergent trajectories in the aging mind: Changes in working memory for affective versus visual information with age. *Psychology and Aging* 2005;20:542–553. [PubMed: 16420130]
- Mroczek DK, Kolarz CM. The effect of age on positive and negative affect: A developmental perspective on happiness. *Journal of Personality and Social Psychology* 1998;75:1333–1349. [PubMed: 9866191]
- Murphy NA, Isaacowitz DM. Preferences for emotional information for younger and older adults: A meta-analysis of memory and attention tasks. *Psychology and Aging* 2008;23:263–286. [PubMed: 18573002]

- Naveh-Benjamin M, Craik FIM, Guez J, Krueger S. Divided attention in younger and older adults: Effects of strategy and relatedness on memory performance and secondary task costs. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 2005;31:520–537.
- Radloff LS. The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement* 1977;1:385–401.
- Rozin P, Rozyman EB. Negativity bias, negativity dominance, and contagion. *Personality and Social Psychology Review* 2001;5:296–320.
- Scheier MF, Carver CS. Optimism, coping, and health: Assessment and implication for generalized coping expectancies. *Health Psychology* 1985;4:219–247. [PubMed: 4029106]
- Smith KN, Larsen JT, Chartrand TL, Cacioppo JT, Katafiasz HA, Moran KE. Being bad isn't always good: Affective context moderates the attention bias toward negative information. *Journal of Personality and Social Psychology* 2006;90:210–220. [PubMed: 16536647]
- Stoltzfus, ER.; Hasher, L.; Zacks, RT. Working memory and aging: Current status of the inhibitory view. In: Richardson, JTE.; Engle, RW.; Hasher, L.; Logie, RH.; Stoltzfus, ER.; Zacks, RT., editors. *Working memory and human cognition*. New York: Oxford University Press; 1996. p. 66-88.
- Thomas RC, Hasher L. The influence of emotional valence on age differences in early processing and memory. *Psychology and Aging* 2006;21:821–825. [PubMed: 17201502]
- Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Development* 1988;54:1063–1070.
- Wegener DT, Petty RE. Mood management across affective states: The hedonic contingency hypothesis. *Journal of Personality and Social Psychology* 1994;66:1034–1048. [PubMed: 8046576]
- Weschler, D. *Manual for the Weschler Adult Intelligence Scale – Revised*. New York: Psychological Corp; 1981.
- Whiting WL. Adult age differences in divided attention: Effects of elaboration during memory encoding. *Aging, Neuropsychology, and Cognition* 2003;10:141–157.
- Xing C, Isaacowitz DM. Aiming at happiness: How motivation affects attention to and memory for emotional images. *Motivation and Emotion* 2006;30:249–256.
- Zachary, R. *Shipley Institute of Living Scale, Revised Manual*. Los Angeles: Western Psychological Services; 1986.

Figure 1. Mean fixation percentages for positive, negative, and neutral images for (A) younger and (B) older adults in the full and divided attention conditions. Error bars represent standard errors of the mean.

Table 1

Mean performance scores on affective and cognitive measures by age

Measure	Younger	Older	<i>t</i>
Total <i>N</i>	20	20	-
Men	4	6	-
Women	16	14	-
Age	21.60 (3.34)	70.45 (8.27)	-
Education	14.10 (2.04)	16.70 (2.32)	3.33**
Health	3.25 (.79)	3.55 (1.19)	0.94
Far-Vision	30.25 (16.26)	49.50 (38.56)	2.06*
Contrast Sensitivity	1.48 (.19)	1.34 (.27)	1.90
Near-Vision	23.25 (4.94)	45.50 (41.64)	2.37*
FTP ^a	54.20 (10.02)	36.95 (11.60)	5.03***
LOT ^b	4.10 (4.63)	6.42 (5.26)	1.46
CES-D ^c	14.70 (8.69)	8.89 (7.87)	2.18*
PA ^d	29.20 (8.56)	31.83 (6.99)	1.03
NA ^d	17.15 (5.97)	12.72 (3.71)	2.71*
MMSE ^e	-	28.60 (1.67)	-
Shipley ^f	14.40 (3.73)	16.30 (2.08)	1.99
Digit Forward ^g	6.84 (1.30)	7.00 (1.41)	0.36
Digit Back ^g	5.21 (1.47)	5.25 (1.25)	0.09
ANT ^h	144.25 (162.00)	122.30 (101.08)	0.51

Note: Standard deviations are in parentheses

^aFuture Time Perspective scale (Carstensen & Lang, 1996)

^bLife Orientation Test (Scheier & Carver, 1985)

^cCenter for Epidemiological Studies Depression Scale (Radloff, 1977)

^dPositive and negative affective subscales of the PANAS (Watson, Clark, & Tellegen, 1988)

^eMini-Mental State Examination (Folstein, Folstein, & McHugh, 1975)

^fShipley Vocabulary Test (Zachary, 1986)

^gForward digit-span and backward digit-span of the Weschler Adult Intelligence Scale-Revised (Weschler, 1981)

^hExecutive function subset of the Attentional Network Test (Fan, McCandliss, Sommer, Raz, & Posner, 2002)

Age groups differ significantly:

 $p < .001$,

**
 $p < .01$,

*
 $p < .05$