Psychology and Aging
2010, Vol. 25, No. 1, 239–245

0882-7974/10/$12.00 DOI: 10.1037/a0018297

The Effect of Valence on Young and Older Adults' Attention in a Rapid Serial Visual Presentation Task

Katherine R. Mickley Steinmetz
Boston College

Keely A. Muscatell
University of California, Los Angeles

Elizabeth A. Kensinger
Boston College

Using a rapid serial visual presentation task, the authors examined how the emotional valence of a word affected young and older adults' abilities to detect another word that closely followed it in temporal proximity. Both age groups detected neutral words better when such words followed a positive or negative arousing word rather than a neutral arousing word. These results suggest that emotion influences attention in a similar fashion for young and older adults. Despite evidence that older adults can sometimes show a "positivity effect" in memory, we found no evidence of increased attention toward positive words for older adults.

Keywords: emotion, attention, aging, valence, positivity effect

People are often exposed to more information than they can process simultaneously, which requires individuals to prioritize certain aspects of information in their attention system. Emotional stimuli belong to a class of stimuli that gains priority (Reisberg & Heuer, 2004; Vuilleumier & Driver, 2007). For example, when reading a newspaper, an individual may notice headlines containing emotional words (e.g., "murder") more readily than headlines that include only neutral words.

Though emotion can "grab" the attention of young adults (Anderson, 2005; Calvo & Lang, 2004; Carretie, Hinojosa, Marin-Loeches, Mecado, & Tapia, 2004), the question of whether similar effects occur in older adults is a topic of debate. Some evidence suggests that attentional processing of emotional stimuli may be similar in young and older adults. Studies in which a visual search paradigm was used to study the effect of emotion on attention found that young and older adults are faster to detect high-arousal targets among distractors than they are to detect low-arousal or neutral targets (Hahn, Carlson, Singer, & Gronlund, 2006; Leclerc & Kensinger, 2008; Mather & Knight, 2006).

Despite these findings, some studies indicate that there is a shift in the processing of emotional information as adults age, such that older adults spend more time processing positive material than do young adults (see review by Mather, 2006). According to socioemotional selectivity theory, as adults near the end of their lives and begin to view time as limited, their goals may change from a focus on exploration and knowledge accumulation toward emotional gratification (Carstensen, Fung, & Charles, 2003). Indeed, some studies have shown that older adults exhibit a positivity bias, such that they are more likely to remember positive information than negative information (Carstensen & Mikels, 2005), and older adults spend more time looking at positive stimuli than at negative stimuli (Issacowitz, Wadlinger, Goren, & Wilson, 2006). However, other studies have found no mnemonic benefit for positive information for older adults (Comblain, D'Argembeau, Van der Linden, & Aldenhoff, 2004; Gruhn, Smith, & Baltes, 2005; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002; Murphy & Isaacowitz, 2008).

It has been proposed that whether a positivity bias occurs or not is critically impacted by the stage of processing that is being examined. Older adults' positivity effect may be elicited by controlled processes (e.g., "top-down processes" that require conscious attention) but may not be apparent on tasks reliant on more automatic processing (e.g., "bottom-up processes" that do not require conscious attention; see Leclerc & Kensinger, 2008, and Mather, 2006, for further discussion). As noted earlier, accumulating evidence suggests that attention is directed toward emotional stimuli in a similar fashion for young and older adults (Hahn, Carlson, Singer, & Gronlund, 2006; Leclerc & Kensinger, 2008; Mather & Knight, 2006), whereas age-related differences may emerge in examinations of sustained attention (e.g., Isaacowitz et al., 2006).

To date, studies of the effects of age on attention to emotional stimuli have focused only on older adults' attention to emotional information and not on their attention to information that is temporally proximate to the emotional item. Thus, it is not clear whether encountering an emotional item impacts the likelihood that young and older adults can detect information that is presented

Katherine R. Mickley Steinmetz and Elizabeth A. Kensinger, Department of Psychology, Boston College; Keely A. Muscatell, Department of Psychology, University of California, Los Angeles.

This research was supported by the National Science Foundation Grant BCS0542694 (to Elizabeth A. Kensinger) and by a National Defense Science and Engineering graduate fellowship (to Katherine R. Mickley Steinmetz). We thank Elizabeth Choi and Jonathan Romiti for assistance with participant recruitment, testing, and data management.

Correspondence concerning this article should be addressed to Katherine R. Mickley Steinmetz, Boston College, McGuinn Hall, 140 Commonwealth Ave., Chestnut Hill, MA 02467. E-mail: mickley@bc.edu

quickly after an emotional item. In other words, if young and older adults' attention is "captured" by emotional stimuli, what effect does this have on their abilities to process subsequent items? Because of the interest in understanding valence-specific changes in older adults' emotional processing (i.e., the "positivity effect"; Mather & Carstensen, 2005), we were particularly interested in examining the effects of valence on young and older adults' abilities to process information presented soon after an emotional item.

To address this question, we used a rapid serial visual presentation (RSVP) task. In this paradigm, participants see a rapid stream of words, containing one or two "target" words that are displayed in a different color or font from the other distractor words. Following presentation of the entire stream of words, participants are asked to report the target words. Researchers conducting RSVP experiments using neutral stimuli have found that when target words are presented in close temporal succession (e.g., with few distractor words between), participants exhibit an "attentional blink," or an inability to report the second target (Chun & Potter, 1995). This attentional blink is thought to occur because participants' attentional resources are directed toward processing the first target (T1), allowing the second target (T2) to escape attentional awareness (Chun & Potter, 1995).

More recently, research has suggested that the emotionality of the words presented in the RSVP task can modify the attentional blink. If the T2 is an emotional word, it seems to be spared from the attentional blink; participants are more likely to detect a T2 if it is emotionally arousing than if it is neutral (Anderson, 2005; Anderson & Phelps, 2001; Keil & Issen, 2004). The present study departed from these prior RSVP studies in three important ways. First, most prior studies have focused on the effects of emotional arousal on RSVP task performance, and here we focused on valence effects. Second, most prior studies have focused on the emotional nature of the T2, while here we examined the way in which the emotionality of the T1 affects participants' abilities to remember the subsequently presented, neutral T2. Finally, previous research with the RSVP paradigm has focused exclusively on young adults, and in the present study, we included a sample of older adults to allow the examination of potential age effects on RSVP task performance.

In manipulating the valence of the T1, we were able to look at the effects of emotion on two abilities: the ability to detect the T1 initially and the ability to form a durable representation of the subsequently presented T2. Previous studies with a focus on retention of words presented at slower speeds have revealed that at least in young adults, emotional stimuli can capture attention, leading to an enhanced ability to remember the emotional word but to an inability to recall the surrounding words (Strange, Hurlemann & Dolan, 2003). Related attention-capture effects have been noted when memory has been examined for complex scenes; the emotional object within a scene often is remembered well, whereas the context often is forgotten (e.g., Reisberg & Heuer, 2004). These studies suggest that emotion might facilitate detection of the emotional T1 but impair reporting of the subsequently presented T2 (and see Ihssen et al., 2009).

Attention-capture effects may not be equivalent for positive and negative stimuli, however, and they may not be similar for young and older adults. With regard to valence effects in young adults, positive emotion often broadens one's attention, expanding one's focus to the context, while negative emotion seems more likely to narrow and restrict the focus of attention onto the emotional item (Fredrickson & Branigan, 2005; Gasper, 2004; Gasper & Clore, 2002; Rowe, Hirsh, & Anderson, 2007). Consistent with this framework, studies have revealed that when a negative item is presented, memory for that item is likely to come at a cost for memory involving temporally or spatially proximate information (e.g., Kensinger, Garoff-Eaton, & Schacter, 2007); by contrast, positive stimuli may enhance the ability to retain at least some contextual elements (e.g., Hurlemann et al., 2005; Talarico, Berntsen, & Rubin, 2008). Because long (multisecond) stimulus presentation rates traditionally have been used in these memory studies, the effects due to initial item processing cannot be easily disentangled from downstream effects related to item rehearsal and retention. By using the RSVP task in the present study, we were able to examine whether these divergent effects of valence might be due to the way in which information initially is attended.

The goals in the present exploratory study were to examine how the emotional valence of the T1 word would affect young and older adults' abilities to detect that word and the subsequently presented T2 word. From prior research, we believed that there were three possible outcomes regarding the effects of valence in the two age groups. First, because the RSVP paradigm tests the effects of emotion at a relatively automatic stage of processing—a stage of emotional processing that may be relatively preserved in aging (Mather, 2006)—the effects of positive and negative valence could be comparable in young and older adults. Second, because older adults may focus more on emotion-relevant information than do young adults (Carstensen & Turk-Charles, 1994), both positive and negative words could have a greater effect on older adults' detection rates than on young adults' detection rates. Third, because positive information may be more salient to older adults than negative information is (Mather, 2006), positive valence might have a greater effect on older adults' abilities to detect information than negative valence.

Method

Participants

All participants were native English speakers with normal or corrected-to-normal vision, and none were taking centrally acting medications. All participants were screened to exclude those who were depressed at the time of the study (participants were excluded if they had a score of greater than 5 on the Depression Inventory; Sheikh & Yesavage, 1986) or who indicated that they had a history of depression. Three older participants were excluded because they chose not to finish the task, so the data from 25 young adults (nine men and 16 women, *M* age = 20.63 years, age range 18–25) and 22 older adults (eight men and 14 women, *M* age = 74.95; age range 60–85; see Table 1 for demographic information and cognitive test scores) were analyzed.

Procedure

Participants completed a total of 340 trials of an RSVP task. On each trial, a sequence of 15 words was presented on a computer screen in Geneva 24-point font. In each word sequence, one or two of the words (the targets; T1 and T2) were presented in blue font

Table 1
Demographic Information and Test Scores for Young and Older Adults: Means and Standard Errors

Adults	Age (years)		Education (years)		Backwards digit span		WAIS-III digit symbol		FAS score		FAS perseverations		Shipley vocabulary		Depression inventory		BAI		Gender
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Young	20.63	0.26	14.79	0.20	8.71	0.41	49.96	1.43	43.88	2.97	0.67	0.29	22.42	0.57	2.71	0.57	5.57	0.96	16 women, 9 men
Older	74.50	1.37	16.70	0.55	7.48	0.49	31.78	1.40	44.04	3.10	1.09	0.36	35.47	0.63	0.35	0.16	3.57	0.77	15 women, 8 men

Note. All values represent raw nonstandardized scores. WAIS-III = Wechsler Adult Intelligence Scale (3rd ed.; Wechsler, 1997). FAS score refers to the total number of words beginning with the letter "F," "A," and "S" produced in 60 s. FAS perseverations reflect the proportion of generated words that were repetitions of previously generated words. Vocabulary from Shipley (1986). Depression inventory from Sheikh and Yesavage (1986). Beck Anxiety Inventory from Beck, Epstein, Brown, and Steer (1988).

while the others were presented in an isoluminant white font (the distractors). In the 280 trials that contained two target words, between one and eight white distractor words were presented between the T1 and T2. At the end of each word sequence, participants were asked to write down on a recording sheet any blue words they detected. For young adults, each word was presented for 60 ms with a 40-ms interstimulus interval (ISI), and for older adults, each word was presented for 100 ms with no ISI. Thus, each trial length (i.e., the time for the word presentation plus the ISI) was equated to 100 ms in both age groups. We chose these different presentation times to eliminate floor effects for the neutral T1–T2 trials in the older adult group. Pilot data revealed that likely because of their slowed processing (Salthouse, 2001), older adults found it difficult to identify words presented at 60 ms. This difficulty led to floor effects for older adults' performance on neutral T1–T2 trials (i.e., older adults could almost never detect the T2, and they sometimes missed the T1 as well). These difficulties with task performance would make it impossible to assess the magnitude of the benefit (or hindrance) conferred to older adults when the T1 was emotional rather than neutral. By slowing the presentation of the words for the older adults, we were able to eliminate the floor effects, allowing us to assess whether there were age differences when we changed the emotional valence of the T1. Due to vision and processing speed difficulties, three older adults could not perform a practice version of the task with these parameters, and so the font size was changed to 36-point font for two participants, and the ISI was raised to 100 ms for one individual.

T2 stimuli were neutral nonarousing words, while T1 stimuli varied in valence. Emotional T1 words were taken from databases with extensive normative data (e.g., the Affective Norms for English Words [ANEW]; Bradley & Lang, 1999) and were selected to be either: negative arousing (e.g., "slaughter"; average valence rating [AVR] = 2.40, average arousal rating [AAR] = 6.38), positive arousing (e.g., "ecstasy"; AVR = 7.49, AAR = 6.14), neutral arousing (e.g., "tennis"; AVR = 5.07, AAR = 5.80), and neutral nonarousing (e.g., "figment"; AVR = 5.20, AAR = 3.87).

To determine whether there were age differences in valence and arousal ratings, we asked a separate group of 20 young adults (ages 18–30 years) and 20 older adults (ages 65–80 years) who did not participate in this study but who met the eligibility requirements to rate the words for valence and arousal (see Kensinger, 2008). Analyses revealed no effects of age on the valence or arousal ratings given to any word category (all ps $> .15$).

Words were matched for word length and word frequency, and positive and negative words were matched for arousal and absolute valence (distance from neutral; determined on the basis of normative data from the ANEW list and from the MRC Psycholinguistic Database; Colthart, 1981). For each type of emotional T1, participants completed 70 trials that included a subsequent T2. Sixty trials included only one target; these catch trials were included to assure that participants would not interpret trials on which they could only report one target as a failure to detect the second target.

Data Analyses

To account for individual and age differences in the ability to report target words, we used corrected scores for all analyses.

When assessing T1 detection accuracy, for each participant, we subtracted the percentage of errors for trials with a neutral nonarousing T1 from the percentage of errors for trials with each other emotional category (negative arousing, positive arousing, neutral arousing). Therefore, when examining the effect of emotion on T1 detection, we subtracted the ability to detect neutral nonarousing T1s from the ability to detect T1s from each other emotional category. Similarly, when examining the effect of emotion on T2 detection, we subtracted the ability to detect a T2 that followed a nonarousing T1 from the ability to detect a T2 that followed a T1 from each other emotional category. When examining T2 detection, we only analyzed trials in which the T1 was detected because the definition of the T2 (as the second target in the word list) was valid only if participants had detected the T1. To test differences between targets that were presented quickly one after the other (with few distractor words in between) and those with a longer lag time (many distractor words in between), we grouped trials into short (1–3 distractor words between the targets), medium (4–5 distractor words between the targets), and long (7–8 distractor words between the targets) lags. For each type of emotional T1 word, there were 10 trials at each individual lag, resulting in 30 trials for each emotional type at the short lag and 20 trials for each emotional type at the medium and long lags. These corrected scores were then analyzed.

Results

Detection of the Emotional Target (T1)

To test for differences in T1 detection rate as a function of valence, we conducted a repeated-measures analysis of variance (ANOVA) with T1 valence (positive, negative, neutral) as a within-subjects factor and age (older, young) as a between-subjects factor. For this analysis, percentage of T1 detection was collapsed across all lags. The ANOVA revealed a significant main effect of T1 valence, $F(2, 90) = 3.955$, $p < .05$, such that positive arousing items were less likely to be detected than neutral arousing items by both age groups (see Figure 1, Panels A and B). The ANOVA

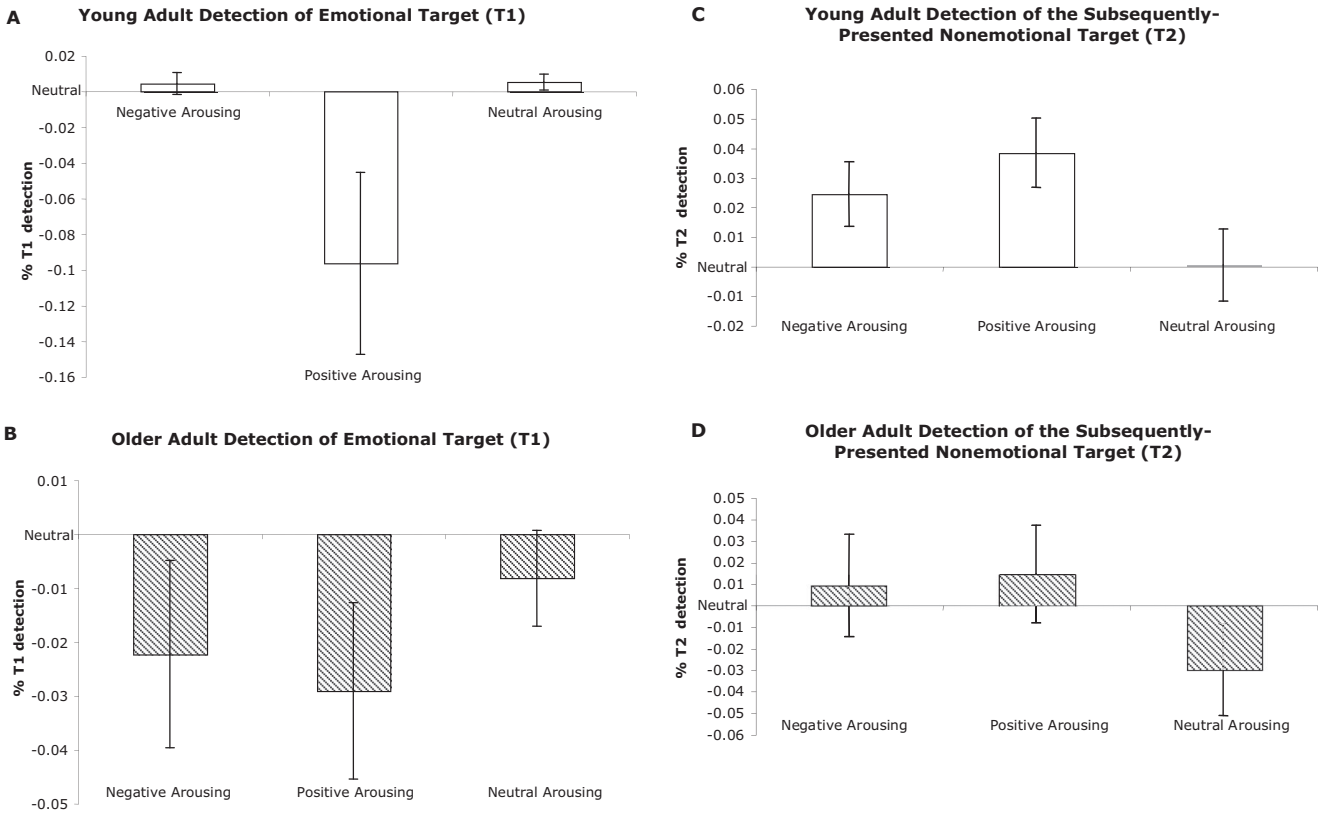

Figure 1. Effect of emotion on detection of the emotional target (Panels A and B) and the subsequently presented neutral target (Panels C and D) in young and older adults. Young (Panel A) and older (Panel B) adults were less likely to detect positive arousing words as compared with neutral arousing words. Both young (Panel C) and older (Panel D) adults were more likely to detect a neutral word if it followed a positive arousing or negative arousing word rather than a neutral arousing word. Detection rates represent difference scores, which we derived by subtracting participants' detection of neutral nonarousing trials from their detection of all other emotional trials. Thus, the *x* axis represents baseline detection given presentation of a neutral nonarousing first target (T1); positive values indicate a higher detection rate than that obtained with presentation of a neutral nonarousing T1, while negative values indicate a lower detection rate than that obtained with presentation of a neutral nonarousing T1. Error bars represent standard error of the mean.

revealed no significant main effect of age and no Age × Valence interaction (all $F < 2.5$, $p > .17$).

Detection of the Subsequently Presented Nonemotional Target (T2)

To determine the influence of valence of the T1 on the detection of the neutral T2, we conducted a repeated-measures ANOVA with T1 valence (positive, negative, neutral) and lag (short, medium, long) as within-subject factors and age as a between-subjects factor. This analysis of the T2 detection rate only included trials on which the T1 was detected, because the definition of the T2 (as the second target in the word list) required that participants had detected the T1. This analysis revealed a significant main effect of T1 valence, $F(2, 44) = 15.903$, $p < .0001$, such that T2s were more likely to be missed following neutral arousing T1s than following valenced (positive arousing or negative arousing) T1s (see Figure 1, Panels C and D). There were no significant main effects of age or lag, and there were no significant interactions (all $F < 2.3$, $p > .11$).

Given that previous research has shown the attentional blink effect to be particularly pronounced at the short lag (Anderson, 2005; Chun & Potter, 1995), we also conducted an ANOVA with age and valence as factors, using only short lag trials. This analysis also revealed a significant main effect of T1 valence, $F(2, 44) = 5.702$, $p < .01$, with more attentional blinks (i.e., more T2 misses) if the T1 was a neutral arousing word than if it was negative arousing one, $t(46) = 2.628$, $p < .05$, or positive arousing, $t(46) = 3.332$, $p < .01$. Once again, there was no significant effect of age and no Age × Valence interaction (all $F < 0.20$, $p > .81$).

Discussion

As we outlined in the introduction, previous literature indicated three possible predictions for the results of the current study: The effects of positive and negative valence on detection could be similar in the two age groups, the effects of positive and negative valence could be exaggerated in the older adults, or the older adults could show an exaggerated influence specifically of positive (and not of negative) valence. The present results are consistent with the first prediction. Both age groups were less likely to detect positive arousing T1 words than negative or neutral ones, and both age groups were more likely to detect neutral T2 words when the words followed the presentation of either a negative or a positive word. The lack of an interaction between valence and age is consistent with previous studies that have indicated that automatic detection may not be affected by aging (Hahn et al., 2006; Leclerc & Kensinger, 2008; Mather & Knight, 2006) and that "bottom-up" processing of emotional material may be preserved with aging (Fleischman, Wilson, Gabrieli, Bienias, & Bennett, 2004; Jennings & Jacoby, 1993). The current research extends prior work by revealing that aging may preserve not only how valenced information is detected but also how valence influences attention to subsequently presented neutral information.

Detection of the Emotional Target (T1)

In terms of detection of the first target word, both age groups were less likely to detect positive arousing words than neutral arousing words. Though it was somewhat surprising that there was no attentional facilitation for positive words, the critical finding was that there was no evidence of age-related changes in emotional detection, and no evidence of a positivity effect in the older adults. This similarity in the two age groups is consistent with research indicating that automatic processing is preserved in aging (Fleischman et al., 2004; Jennings & Jacoby, 1993) and that changes in older adults' emotional processing may be tied more to motivationally controlled processes than to automatic processes (Mather, 2006).

Though some researchers have focused on the effect of arousal on attention (Anderson, 2005; Calvo & Lang, 2004; Carretie et al., 2004; Juth, Lundvist, Karlsson, & Ohman, 2005; Nummenmaa, Hyönä, & Calvo, 2006), others have argued that valence may also play an important role, with positive information "grabbing" attention less often than negative information (Miu, Heilman, Opre, & Miclea, 2005; Strange et al., 2003). The current findings are consistent with these conclusions and emphasize the importance of researchers' considering valence when examining detection of emotional stimuli. Positive T1s may not be prioritized for processing as much as the other emotional items, thereby creating a detection deficit for those positive items.

Detection of the Subsequently Presented Nonemotional Target (T2)

Young and older adults also showed a similar pattern of detection for the neutral words that followed the T1s. Specifically, participants in both age groups were more likely to detect the T2 if it was preceded by a positive or a negative arousing word than a neutral arousing word. This effect is somewhat surprising because research has suggested that positive information may broaden attention while negative information may narrow it (Fredrickson & Branigan, 2005; Gasper, 2004; Gasper & Clore, 2002; Rowe, Hirsh, & Anderson, 2007). By this account, it might be expected that positive emotion would lead to heightened attention for surrounding information while negative emotion would constrain attention to that negative word. Yet in the present study, both positive and negative information appeared to broaden attention such that participants were more likely to detect a T2 if it followed a valenced word as compared with a neutral arousing word.

There is some evidence to suggest that any emotion that motivates an individual will lead to an expansion of attention (Liberman & Foerster, 2005; Liberman, Foerster, & Higgins, 2005), and so it is possible that the present results can be explained within this framework. The presence of an emotional stimulus may induce a motivating goal to direct attention to other information in the environment. In the case of the RSVP task, once motivational goals are activated by an emotional T1, a person may become more attuned to detecting subsequently presented stimuli. At this point, we can only speculate as to whether this could be the mechanism behind the effects shown in this study, but regardless of the exact reason for the broadening of attention, the critical finding is that this attentional broadening happened in the same manner for both young and older adults; there was no evidence that valence differentially affected older adults' attention allocation.

One limitation of the study was that in order to prevent floor effects, we used longer presentation times for the older adult

group. While older adults were shown each word for 100 ms (with no ISI), young adults were shown each word for 60 ms with a 40-ms ISI. Although this modified presentation kept constant the 100-ms trial length, it is possible that an interaction between age and valence would be apparent were it possible to equate the presentation times for the two age groups. Despite this ambiguity with regard to the comparison between the age groups, the present results clearly reveal that at the most rapid presentation that allows for above-floor performance, older adults show no evidence of being more likely to detect positive T1s, nor do they show evidence of a disproportionate influence of positive (vs. negative) valence on the detection of neutral T2s.

In sum, results from the present study suggest that there are minimal age differences on the RSVP task, a task believed to be reliant on the relatively automatic processing of emotional information. These results fit nicely with a growing literature in this domain by revealing that not only is emotional target detection preserved with aging (e.g., Hahn et al., 2006; Leclerc & Kensinger, 2008; Mather et al., 2004) but so too are the effects of emotional valence on detection of subsequently presented information. In the future, researchers should aim to elucidate the neural mechanisms supporting these effects, in an effort to determine whether both young and older adults recruit similar processes to complete the task or whether there are age differences in neural mechanisms that lead to a similar behavioral outcome.

References

Anderson, A. K. (2005). Affective influences on the attentional dynamics supporting awareness. *Journal of Experimental Psychology: General, 134,* 258–261.

Anderson, A. K., & Phelps, E. A. (2001, May 17). Lesions of the human amygdala impair enhanced perception of emotionally salient events. *Nature, 411,* 305–309.

Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: Psychometric properties. *Journal of Consulting and Clinical Psychology, 56,* 893–897.

Bradley, M. M., & Lang, P. J. (1999). *Affective norms for English words (ANEW): Instruction manual and affective ratings* (Tech. Rep. No. C-1). Gainesville: University of Florida, The Center for Research in Psychophysiology.

Calvo, M. G., & Lang, P. J. (2004). Gaze patterns when looking at emotional pictures: Motivationally biased attention. *Motivation and Emotion, 28,* 221–243.

Carretie, L., Hinojosa, J. A., Martin-Loeches, M., Mercado, F., & Tapia, M. (2004). Automatic attention to emotional stimuli: Neural correlates. *Human Brain Mapping, 22,* 290–299.

Carstensen, L. L., Fung, H. H., & Charles, S. T. (2003). Socioemotional selectivity theory and the regulation of emotion in the second half of life. *Motivation and Emotion, 27,* 103–123.

Carstensen, L. L., & Mikels, J. A. (2005). At the intersection of emotion and cognition. *Current Directions in Psychological Science, 14,* 117–121.

Carstensen, L. L., & Turk-Charles, S. (1994). The salience of emotion across the adult life span. *Psychology and Aging, 9,* 259–264.

Chun, M. M., & Potter, M. C. (1995). A two-stage model for multiple target detection in rapid serial visual presentation. *Journal of Experimental Psychology, 21,* 109–127.

Colthart, M. (1981). The MRC psycholinguistic database. *Quarterly Journal of Experimental Psychology, 33*A, 497–505.

Comblain, C., D'Argembeau, A., Van der Linden, M., & Aldenhoff, L. (2004). The effect of ageing on the recollection of emotional and neutral pictures. *Memory, 12,* 673–684.

Fleischman, D. A., Wilson, R. S., Gabrieli, J. D. E., Bienias, J. L., & Bennett, D. A. (2004). A longitudinal study of implicit and explicit memory in old persons. *Psychology and Aging, 19,* 617–625.

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition and Emotion, 19,* 313–332.

Gasper, K. (2004). Do you see what I see? Affect and visual information processing. *Cognition & Emotion, 18,* 405–421.

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global vs. local processing of visual information. *Psychological Science, 13,* 34–40.

Gruhn, D., Smith, J., & Baltes, P. B. (2005). No aging bias favoring memory for positive material: Evidence from a heterogeneity–homogeneity list paradigm using emotionally toned words. *Psychology and Aging, 20,* 579–588.

Hahn, S., Carlson, C., Singer, S., & Gronlund, S. D. (2006). Aging and visual search: Automatic and controlled attentional bias to threat faces. *Acta Psychologica, 123,* 312–336.

Hurlemann, R., Hawellek, B., Matusch, A., Kolsch, H., Wollersen, H., Madea, B., . . . Dolan, R. J. (2005). Noradrenergic modulation of emotion-induced forgetting and remembering. *Journal of Neuroscience, 25,* 6343–6349.

Ihssen, N., & Keil, A. (2009). The costs and benefits of processing emotional stimuli during rapid serial visual presentation. *Cognition and Emotion, 23,* 296–326.

Isaacowitz, D. M., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2006). Selective preference in visual fixation away from negative images in old age? An eye-tracking study. *Psychology and Aging, 21,* 40–48.

Jennings, J. M., & Jacoby, L. L. (1993). Automatic versus intentional uses of memory: Aging, attention, and control. *Psychology and Aging, 8,* 283–293.

Juth, P., Lundqvist, D., Karlsson, A., & Ohman, A. (2005). Looking for foes and friends: Perceptual and emotional factors when finding a face in the crowd. *Emotion, 5,* 379–395.

Keil, A., & Ihssen, N. (2004). Identification facilitation for emotionally arousing verbs during the attentional blink. *Emotion, 4,* 23–25.

Kensinger, E. A. (2008). Age differences in memory for arousing and nonarousing emotional words. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 63,* 13–18.

Kensinger, E. A., Brierley, B., Medford, N., Growdon, J. H., & Corkin, S. (2002). The effect of normal aging and Alzheimer's disease on emotional memory. *Emotion, 2,* 118–134.

Kensinger, E. A., Garoff-Eaton, R. J., & Schacter, D. L. (2007). Effects of emotion on memory specificity: Memory trade-offs elicited by negative visually arousing stimuli. *Journal of Memory and Language, 56,* 575–591.

Leclerc, C. M., & Kensinger, E. A. (2008). Effects of age on detection of emotional information. *Psychology and Aging, 23,* 209–215.

Liberman, N., & Foerster, J. (2005). Motivation and construct accessibility. In J. P. Forgas, K. D. Williams, & S. M. Laham (Eds.), *Social motivation: Conscious and unconscious processes* (pp. 228–245). Cambridge, MA: Cambridge University Press.

Liberman, N., Foerster, J., & Higgins, T. (2005). Accessibility from active and fulfilled goals. *Journal of Experimental Social Psychology, 41,* 220–239.

Mather, M. (2006). Why memories may become more positive as people age. In B. Uttl, N. Ohta, & A. L. Siegenthaler (Eds.), *Memory and emotion: Interdisciplinary perspectives* (pp. 135–159). Malden, MA: Blackwell.

Mather, M., Canli, T., English, T., Whitfield, S., Wais, P., Ochsner, K., . . . Carstensen, L. (2004). Amygdala responses to emotionally valenced

stimuli in older and younger adults. *Psychological Science, 15,* 259–263.

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: the positivity effect in attention and memory. *Trends in Cognitive Sciences, 9,* 296–502.

Mather, M., & Knight, M. R. (2006). Angry faces get noticed quickly: Threat detection is not impaired among older adults. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 61,* 54–57.

Miu, A. C., Heilman, R. M., Opre, A., & Miclea, M. (2005). Emotion-induced retrograde amnesia and trait anxiety. *Journal of Experimental Psychology, 31,* 1250–1257.

Murphy, N. A., & Isaacowitz, D. M. (2008). Preferences for emotional information in older and younger adults: A meta-analysis of memory and attention tasks. *Psychology and Aging, 23,* 263–286.

Nummenmaa, L., Hyönä, J., & Calvo, M. G. (2006). Eye movement assessment of selective attentional capture by emotional pictures. *Emotion, 6,* 257–268.

Reisberg, D., & Heuer, F. (2004). Memory for emotional events. In D. Reisberg and P. Hertel (Eds.), *Memory and emotion.* New York, NY: Oxford University Press.

Rowe, G., Hirsh, J. B., & Anderson, A. K. (2007). Positive affect increases the breadth of attentional selection. *Proceedings of the National Academy of Sciences of the United States of America, 104,* 383–388.

Salthouse, T. A. (2001). Structural models of the relations between age and measures of cognitive functioning. *Intelligence, 29,* 9–115.

Sheikh, J. I., & Yesavage, J. A. (1986). Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version. In T. L. Brink (Ed.), *Clinical Gerontology: A Guide to Assessment and Intervention* (pp. 165–173). New York, NY: Haworth Press.

Shipley, W. C. (1986). *Shipley Institute of Living Scale*. Los Angeles, CA: Western Psychological Services.

Strange, B. A., Hurleman, R., & Dolan, R. J. (2003). An emotion-induced retrograde amnesia in humans is amygdala- and beta-adrenergic dependent. *Proceedings of the National Academy of Sciences of the United States of America, 100,* 13626–13631.

Talarico, J., Berntsen, D., & Rubin, R. (2008). Positive emotions enhance recall of peripheral details. *Cognition and Emotion, 23,* 380–398.

Vuilleumier, P., & Driver, J. (2007). Modulation of visual processing by attention and emotion: Windows on causal interactions between human brain regions. *Philosophical Transactions of the Royal Society London B: Biological Sciences, 362,* 837–855.

Wechsler, D. (1997). *Technical manual for the Wechsler Adult Intelligence and Memory Scale* (3rd ed.). New York, NY: Psychological Corporation.

Received December 8, 2008
Revision received August 3, 2009
Accepted November 4, 2009 ■