Journal of Gerontology: PSYCHOLOGICAL SCIENCES
2002, Vol. 57B, No. 1, P65–P73

Gaze Aversion: Spared Inhibition for Visual Distraction in Older Adults

Gilles O. Einstein,[1] Julie L. Earles,[2] and Heather M. Collins[1]

[1]Department of Psychology, Furman University, Greenville, South Carolina.
[2]Department of Psychology, Honors College at Florida Atlantic University, Jupiter.

Our everyday environment is filled with irrelevant and potentially distracting information. Recent research has shown that during retrieval people tend to look away from distraction or close their eyes and that averting one's gaze benefits retrieval. We examined the extent to which there are age-related differences in the benefits of gaze aversion and whether the benefits of gaze aversion extend to encoding. Relative to looking at complex stimuli, closing the eyes and looking at simple stimuli produced reliable improvements in memory for both younger and older adults at both encoding and retrieval. Contrary to the expectation that older adults have general inhibitory deficits, the benefits of gaze aversion were similar for younger and older adults at both encoding and retrieval. These results are consistent with the view that older adults have spared inhibitory functioning for distraction appearing in fixed locations.

GLENBERG, Schroeder, and Robertson (1998) have recently shown that people tend to avert their gazes (close their eyes, look away) when retrieving moderately difficult information and that gaze aversion can have benefits for retrieval. Glenberg and colleagues developed the adaptive significance of gaze aversion within a broader theory of perception, action, and cognition (see also Glenberg, 1997). The basic idea is that survival requires that people's actions be made within constraints imposed by the environment. Because there is usually a need to attend to the constellation of features present in the environment, it is important that people's cognitive systems be "clamped to the environment" (Glenberg et al., 1998, p. 651). Otherwise, traversing through the environment would be hazardous. Indeed, most people have experienced a stumble or fall in situations where they have been engrossed in thought and momentarily disengaged from the environment.

Although control by the environment is adaptive in most cases, assuming that processing of the environment demands resources, being clamped to the environment can interfere with the processing of information that is unrelated to stimuli present in the immediate environment. For example, while seated on a train, processing of stimuli in the visual environment may reduce the resources available for solving a math problem or recalling the name of a restaurant one worked in while in college. One mechanism for minimizing environmental distraction in these circumstances is to actively inhibit the activation of the environmental stimuli (Tipper, Weaver, Cameron, Brehaut, & Bastedo, 1991). Presumably, this suppression of environmental distractions is accomplished by an inhibitory attentional mechanism, and this results in increased resources available for processing relevant information. Another mechanism, perhaps simpler and less taxing in terms of attentional resources, is to effectively disengage from the environment by averting one's gaze.

People's normal environments are replete with potentially distracting information, and we thought it important to test the robustness of the benefits of gaze aversion while examining other issues. The previous research on gaze aversion (Glenberg et al., 1998) has been limited to younger adults, and an important empirical and theoretical issue is whether there are age-related differences in the extent to which averting the gaze benefits cognitive processing. According to Hasher and Zacks (1988; Zacks & Hasher, 1994), inhibition plays a critical role in controlling the contents of working memory, and aging disrupts the efficient functioning of this attentional mechanism. Within their view, older adults have more difficulty preventing irrelevant information (e.g., irrelevant environmental distractions, personalistic memories) from entering working memory and ridding working memory of information that is no longer useful. There are a variety of results consistent with this view, including those showing greater negative priming (thought to be an important measure of inhibition) in younger adults relative to older adults (Earles, Connor, Frieske, Park, & Smith, 1997; Hasher, Stoltzfus, Zacks, & Rypma, 1991; Tipper, 1991; Verhaeghen & DeMeersman, 1998), reduced inhibition for older adults for thoughts that are no longer correct or relevant (May & Hasher, 1998), and greater susceptibility of older adults to the interfering effects of irrelevant words embedded in short texts (Connelly, Hasher, & Zacks, 1991). Thus, problems in inhibitory functioning suggest that older adults should particularly benefit from other methods—such as gaze aversion—that limit the entry of irrelevant environmental stimulation into working memory.

A more refined analysis of the inhibition literature suggests a different prediction. It is widely believed that older adults are more susceptible to distraction than younger adults, yet there is a growing body of literature that questions the magnitude, interpretation, and generality of age-related inhibitory declines. Although several studies (Kramer, Humphrey, Larish, Logan, & Strayer, 1994; Schooler, Neumann, Caplan, & Roberts, 1997; Sullivan & Faust, 1993) have shown equivalent levels of negative priming for younger and older adults, Verhaeghen and DeMeersman's (1998) recent meta-analysis of the available literature suggests a small but reliable age difference in negative priming (with younger adults showing a larger effect). Still at issue, however, is whether small age differences in inhibition can produce noticeable age differences in sensitivity to distraction. Also, Neill, Valdes, and Terry (1995) and others have argued that memory-based processes rather than inhibition could account for age differences in negative priming.

Whereas some research has questioned whether there are general age-related decrements in the ability to inhibit external stimulation, other research has shown spared inhibitory functioning in older adults under certain conditions (Carlson, Hasher, Connelly, & Zacks, 1995; Connelly & Hasher, 1993; Hasher, Zacks, & May, 1999). In a recent meta-analytic review of seven studies, Verhaeghen and DeMeersman (1998) found preserved location inhibition by older adults as measured by negative priming. Perhaps even more closely related to the current research, Carlson and associates (1995) found that older adults were quite adept at ignoring irrelevant words in a text when those words appeared in fixed and predictable locations (e.g., every other line or in fixed column locations). Older adults were, however, severely disrupted when the to-be-ignored text appeared in random locations. Thus, if older adults can effectively inhibit distracting information appearing in fixed locations, the benefits of gaze aversion should be similar for younger and older adults under certain distraction conditions. If it is found that older adults are able to suppress entire visual scenes as well as younger adults, then the results would supply good evidence for spared inhibitory ability with more natural and possibly more complex material than has been heretofore shown.

To evaluate these different views, we tested both younger and older participants and asked them to process information with their eyes closed or while viewing irrelevant stimuli that were either simple (a fixation cross) or complex (color photographs of flowers and animals). The to-be-processed material was presented auditorially, whereas the to-be-ignored material was presented visually in a fixed and predictable location (i.e., a computer screen). According to the view that older adults have broad-based problems in limiting the entrance of irrelevant information into working memory, closing one's eyes (and possibly viewing simple stimuli) should greatly enhance the performance of older participants (relative to viewing complex stimuli). On the other hand, if inhibitory processes are minimally affected by age and/or especially the ability to inhibit on the basis of fixed locations, then the benefits of reducing distraction should be similar for younger and older adults.

Another major goal of the present research was to examine whether the benefits of gaze aversion occur at encoding as well as at retrieval and to determine the relative benefits across encoding and retrieval. We are not aware of any work that has examined the effects of gaze aversion on encoding, despite the practical and theoretical implications of this research. In everyday life, we often process information (e.g., listen to telephone messages) while exposed to visual distraction (e.g., looking at a computer screen), and it would be useful to examine the effects of this type of distraction. On the basis of results showing large effects of dividing attention at encoding on memory performance but small or no effects of dividing attention at retrieval, Craik, Govoni, Naveh-Benjamin, and Anderson (1996; see also Anderson, Craik, & Naveh-Benjamin, 1998) have proposed that once retrieval processes are initiated, they "are in some sense obligatory, or are protected" (p. 177). Thus, gaze aversion may be particularly beneficial during encoding (relative to retrieval), and this pattern might be accentuated for older adults (Park, Smith, Dudley, & Lafronza, 1989; but see Anderson et al., 1998 for similar age effects of dividing attention at encoding and retrieval).

On the other hand, divided attention results may not be very useful for anticipating the effects of gaze aversion. This is because participants in divided attention experiments are required to place significant (and in many cases primary) emphasis on the secondary or "distracting" task. In the context of gaze aversion, however, participants attempt to ignore the distraction, and this situation seems more pertinent to real-world conditions in which people try to minimize the distracting influence of irrelevant stimuli (cf. Park, 1992). Although Craik and colleagues (1996) did not include an ignore condition in their experiment, they found more similar effects of dividing attention at encoding and retrieval (though still larger at encoding) when they deemphasized the divided attention task. If we extrapolate these results to a condition in which participants attempt to ignore the distracting information, the benefits of gaze aversion may be similar at encoding and retrieval.

Experiment 1

In the first experiment, we presented younger and older adults with word pairs for study and then gave them a cued recall test. In addition to varying whether or not participants closed their eyes (distraction manipulation) during encoding and retrieval, we varied whether the word pairs were related or unrelated. This was done in order to create some variability in the difficulty of encoding and retrieval, as Glenberg and colleagues (1998) have shown the benefits of gaze aversion are more likely with moderately difficult material.

We also included an additional condition that was designed to help us more clearly evaluate the benefits of gaze aversion. In Experiment 4 of the Glenberg and colleagues (1998) article, they showed that closing one's eyes (relative to looking at the experimenter's nose—a situation that is likely to be highly distracting) increased performance on moderately difficult questions, whereas in Experiment 5, they showed that focusing on a picture of a sunset (relative to a movie clip) increased recall of a word list. What is not clear from their work is whether there are additional benefits to closing the eyes relative to diverting one's gaze to simpler stimulation, and one goal of the present research was to examine this question. Thus, in the present experiment, participants processed verbal material while closing their eyes, focusing on a small fixation cross (a constant and simple stimulus) or focusing on regularly changing pictures of animals and flowers (complex stimuli).

Method

Design and participants.—The design of this experiment was a 2 × 2 × 3 × 2 mixed factorial that included the between-subjects variables of age (younger, older) and phase of the distraction manipulation (encoding, retrieval) and the within-subjects variables of distraction condition (closed eyes, simple distraction, complex distraction) and type of word pair (unrelated, related). Eighteen participants were assigned to each of the four different between-subjects conditions. The younger participants were 18–22-year-old introductory psychology students at Furman University who participated to fulfill a course requirement. The older adults were 60–77-year-old community-dwelling adults who received $10 for participating. All were sufficiently healthy to be able to drive to campus to be tested. Older adults (M = 16.72) scored reliably higher than the younger adults (M = 15.25) on the Mill Hill Vocabulary Test (Raven, 1965), $F(1, 70) = 8.08$, $MSE = 4.83$. Older adults (M = 15.64) had reliably more years in the educational system than younger adults (M = 13.72), $F(1, 70) = 16.13$, $MSE = 3.17$. The rated health of both younger and older adults was high (above 4.0 on a scale ranging from 1, indicating poor health, to 5, indicating excellent health). Although rated health was nominally higher for younger adults (M = 4.39) relative to older adults (M = 4.08), the difference was not reliable, $F(1, 70) = 3.33$, $MSE = 0.50$. Each participant was tested individually.

Procedure.—Initially, all participants were seated in front of a microcomputer and told that we were interested in their ability to learn word pairs. They were told that they would be presented with two lists consisting of pairs of words and that following each list they would be presented with the first word of each pair as a cue to help them recall the second word.

The general procedure was as follows. All word pairs and cues were presented auditorially via a computer, and all participants received two lists of 24 pairs each. Each pair was presented within an 8-s interval, and following the last pair, participants were given a 2-min distractor task. Next, participants were auditorially presented with the first member of each pair and asked to recall the second member of the pair within 10 s. Following presentation of the items and cued recall with the first list, the identical procedure was used to present and test the second list. To familiarize participants with the cued recall procedure, they were given practice that consisted of presentation and testing with four pairs.

The distractor task, which was not used in the practice, tested participants' perceptual speed. The distractor task following the first list was the Letter Comparison test, and the one following the second list was the Pattern Comparison test (both of these tests were developed by Salthouse & Babcock, 1991). For these tests, participants were presented with pairs of letter strings (or patterns) and asked to write an *S* if the letter strings (patterns) were the same and a *D* if they were different. Each participant received three 30-s trials for each type of test (letter, pattern). Thus, the distractor period before cued recall lasted about 2 min (three 30-s periods plus instruction).

For one half of the participants, the distraction condition was varied during encoding. These participants were told that while trying to learn the auditorially presented words, they would be asked either to close their eyes or to focus on the computer screen in front of them. Preceding each block of eight word pairs, an auditory instruction was presented (via computer) that informed participants about whether they should close their eyes or look at the computer screen. During the closed-eye block, the computer screen was blank; during the simple distraction period, participants viewed a small cross in the middle of the computer screen; and during the complex distraction condition, participants viewed color photographs of animals or flowers (a new photograph appeared with the presentation of each word pair) on the computer screen. The order of the word blocks was the same for all participants, but we created three counterbalancing conditions to control for items across distraction conditions. Thus, across all participants, each distraction condition appeared in each serial order (i.e., first, second, third) an equal number of times.

To ensure compliance with the instructions, we alerted participants to a mirror that was hung on the wall above the computer and instructed them to look at it. This resulted in eye contact with the experimenter, who was sitting a few feet behind them. Participants were told that the experimenter was there to monitor whether they were performing as instructed and that the experimenter would alert them whenever they did not follow instructions. There was virtually complete compliance with the instructions as there were only two cases (less than 0.1% of the cases) in which the experimenter had to make a comment to a participant. In both of these cases, the experimenter's reminder was quickly followed by adherence to the instructions.

Following the perceptual speed distractor task, the first member of each word pair was presented one at a time and in a random order, and participants were given 10 s to recall orally the second member of the pair. During recall, the computer screen was blank, and participants were not told anything about closing or opening their eyes. They were simply told to do the best that they could. Next, participants were presented with another 24-item list of word pairs, and the same procedure was followed.

For the other half of the participants, the distraction condition was varied during retrieval. These participants were given standard learning instructions during the presentation of the word pairs (and the computer screen was blank), and the distraction manipulation occurred during cued recall. The distraction manipulation was identical in form to the one described above for the encoding manipulation. That is, during cued recall, participants either closed their eyes or kept their eyes open for blocks of eight cues. When the eyes were open and the participants were looking at the computer screen, a small cross appeared during one block of trials and pictures of animals or flowers appeared during another block of trials. Again, in the complex distraction condition, the presentation of the distractor pictures was yoked to that of the cues, such that a new picture was presented every 10 s.

Materials.—We used the Palermo and Jenkins (1964) association norms to select 48 pairs of moderately related items (e.g., drama–comedy). These 48 pairs were then repaired to create another list of 48 pairs of unrelated items (e.g., drama–skirt). From these 96 pairs, we constructed two nonoverlapping sets of pairs with each containing 48 pairs. In each 48-pair list, 24 of the pairs were related and 24 were unrelated. Half of the participants received one set, and the other half received the other set.

Each set of 48 pairs was divided into two lists. Each of these two lists contained three blocks of eight randomly ordered pairs, four of which were related and four of which were unrelated. For each list of word pairs, the presentation order was the same for all participants. The order of the distraction condition was varied across participants such that each distraction condition occurred equally often in each of the three block positions.

At retrieval, the cues were presented in the same blocks used during encoding. The order of the blocks was identical to that used during encoding, but we created a new random order of the cues within a block (which was constant for all participants receiving that set of items).

Results and Discussion

Unless otherwise indicated, the rejection level for inferring statistical significance was set at .05. To examine the influence of averting the gaze on cued recall, we tabulated the proportion of related and unrelated items correctly recalled (out of eight possible items) under the closed-eye, simple distraction, and complex distraction conditions, and we averaged performance across the two lists. These data were subjected to a $2 \times 2 \times 3 \times 2$ mixed analysis of variance (ANOVA), which included the between-subjects variables of age (younger, older) and phase (encoding, retrieval) and the within-subjects variables of distraction (closed eye, simple distraction, complex distraction) and type of word pair (unrelated, related); see Appendix, Note 1. The means for each of the conditions are presented in Figure 1.

There was a reliable effect of distraction condition, $F(2, 136) = 4.96$, $MSE = 0.03$, $p = .008$. As can be seen in Figure 1, cued recall was higher in the closed-eye ($M = .540$, $SD = .260$) and simple distraction ($M = .535$, $SD = .250$) condition than in the complex distraction ($M = .479$, $SD = .250$) condition for almost all groups. These observations were verified with planned contrasts showing a significant difference between the closed-eye and complex distraction condition, $F(1, 136) = 4.07$, $MSE = 0.033$, and a marginally significant ($p < .10$) difference between the simple and complex distraction conditions, $F(1, 136) = 3.43$, $MSE = 0.033$.

As can be seen in Figure 1, there was a highly reliable effect of age, with younger participants ($M = .68$, $SD = .15$) recalling nearly twice as many items as the older participants ($M = .36$, $SD = .18$), $F(1, 68) = 62.32$, $MSE = 0.18$. The main effect of distraction described above, combined with the lack of any evidence for an interaction with age ($F < 1$), indicates that the benefits of reducing distraction extend to older adults. Contrary to the view that older adults might be especially sensitive to all types of external distraction, there was no evidence that reducing distraction was more beneficial to older compared with younger participants. Indeed, the benefits of closing the eyes and simplifying the distraction (relative to complex distraction) were nominally greater for younger participants (Ms = .08 and .07, respectively) than for older participants (Ms = .05 and .05, respectively). Although there are always dangers associated with accepting the null hypothesis, 36 participants contributed scores to each of these means (which is a large number for memory research), and the interaction effect

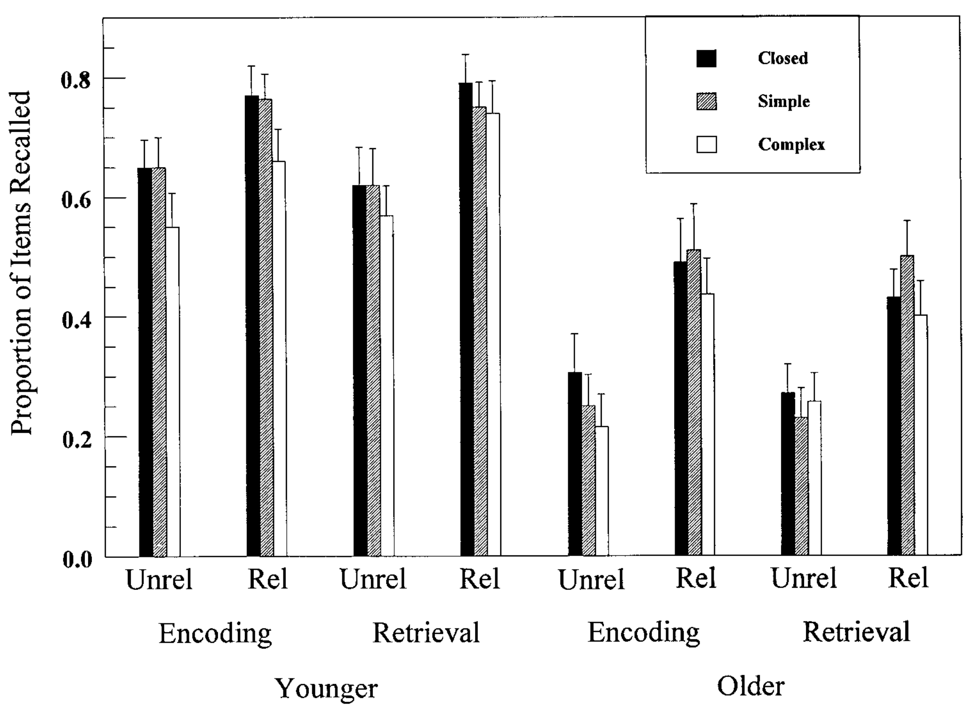

Figure 1. Mean proportion of items recalled as a function of type of distraction, pair relatedness, phase of distraction, and age (error bars represent the standard error of the mean). Unrel = unrelated; Rel = related.

was very small and in the direction opposite to that predicted. Thus, it seems unlikely that older adults benefited more from gaze aversion than younger adults.

One problem in evaluating whether benefits of gaze aversion were greater for younger or older adults is that the groups differed in their overall levels of cued recall. Ideally, when examining whether an effect is greater for one age group than another, one would want to start off with equivalent levels of recall. Although this is not possible with our data, we can more nearly equate the recall levels of younger and older adults by comparing the data from the unrelated lists of younger adults (M = .61) with those from the related lists of older adults (M = .46; collapsed across distraction conditions). Under these conditions, the benefits of closing the eyes and simplifying distraction were still greater for younger adults (Ms = .08 and .08, respectively) relative to older adults (Ms = .04 and .08, respectively). If these benefits are considered as proportional increases relative to the complex condition, then the average benefit of avoiding complex distraction was almost identical for younger adults (Ms = .14 and .14, respectively) and older adults (Ms = .09 and .19, respectively).

Another goal of this research was to determine whether the benefits of reducing distraction would extend to encoding. As can be seen in Figure 1, this appears to be the case as there was no evidence for an interaction between the time of the distraction manipulation (encoding, retrieval) and the distraction condition ($F < 1$). Also, there was no indication that the benefits of reducing distraction at encoding (or at retrieval) were more pronounced for older relative to younger adults ($F < 1$).

As is evident in Figure 1, cued recall was higher with the related lists (M = .60, SD = .23) than with the unrelated lists (M = .43, SD = .26), $F(1, 68) = 77.84$, $MSE = 0.04$. There was also a marginally reliable interaction between age and type of list, $F(1, 68) = 3.42$, $MSE = 0.04$, $p = .07$. This effect revealed that the age difference was larger with the unrelated material than with the related material, and this finding is consistent with others in the literature (e.g., Park, Smith, Morrell, Puglisi, & Dudley, 1990). The failure to find an interaction between distraction condition and the relatedness of the items indicates that the effects of distraction in our experiment did not depend on the difficulty of the materials. No other effects approached significance (all Fs ≤ 1.57).

In summary, these results reveal that the benefits of gaze aversion and reducing distraction are modest but similar for younger and older adults. As such, they argue against the view that older adults have widespread difficulty inhibiting external distractions of all types. The results are more consistent with those of recent research (Carlson et al., 1995) showing preserved inhibitory functioning under certain conditions. Specifically, it appears that older adults can effectively inhibit external visual distractions appearing in fixed locations while processing auditorily presented information. Also in contrast to results from the divided attention literature, the benefits of reducing distraction were similar at encoding and retrieval. We return to discussing these issues after presenting a second experiment that tested the generality of our aging effects.

Experiment 2

In this experiment, we manipulated distraction only at retrieval. Younger and older adults encoded concrete and abstract items and were then asked to free recall these items with their eyes closed or while looking at a continuously changing design on a computer screen. We wanted to examine whether our failure to find increased benefits of gaze aversion for older adults could be replicated under conditions that might be more likely to produce age-related benefits. Specifically, we used constantly active animation rather than a series of still pictures as the distraction. Also, because free recall tends to be especially difficult for older adults (Craik, 1986) and is more sensitive to the effects of dividing attention (Craik et al., 1996), we thought that this would be the most sensitive retrieval condition under which to explore differential age-related benefits of gaze aversion.

Method

Design and participants.—The design of this study was a 2 × 2 × 2 mixed factorial and included the between-subjects variables of age (younger, older) and distraction condition during retrieval (closed eye, distraction) and the within-subjects variable of type of item (concrete, abstract). Twelve participants were assigned to each of the four conditions, and all participants were tested individually. The younger participants were 17–22-year-old students at Furman University, and they participated to meet a requirement for a general psychology course. The older participants were 60–80 years old and community dwelling, and they received $10 for participating. As in the first experiment, the older adults (M = 15.54) scored significantly higher than the younger adults (M = 14.25) on the Mill Hill Vocabulary Test (Raven, 1965), $F(1, 46) = 6.56$, $MSE = 3.05$. Older adults (M = 15.79) had significantly more years of education relative to younger adults (M = 14.08), $F(1, 46) = 11.05$, $MSE = 3.17$. As in the first experiment, the rated health of both younger and older adults was high (above 4.0 on a scale ranging from 1, indicating poor health, to 5, indicating excellent health). This time, however, rated health was significantly higher for younger adults (M = 4.46) relative to older adults (M = 4.13), $F(1, 46) = 4.21$, $MSE = 0.32$.

Procedure and materials.—All participants received the same instructions during the study phase of the experiment. Specifically, they were initially told that they would hear a list of words presented by a tape recorder and that they should study these items for a later memory test.

Each participant was presented 12 concrete and 12 abstract items, and these were presented at the rate of 6 s per item. Three different lists were constructed, and one third of the participants in each condition received each list. Abstract items were words that had a rating of 3.41 and lower on the concreteness dimension of the Toglia and Battig (1978) word norms, and concrete items were those with ratings of 4.86 and higher. Although varying concreteness, we equated the words on familiarity and meaningfulness such that the mean concreteness, familiarity, and meaningfulness ratings, respectively, were as follows: 2.89, 5.99, and 4.04 for the abstract items on List 1; 5.71, 5.93, and 4.22 for the concrete items on List 1; 3.02, 6.15, and 4.21 for the abstract items on List 2; 5.58, 6.03, and 4.16 for the concrete items on List 2; 3.05, 6.00, and 4.03 for the abstract items on List 3; and 5.62, 6.12, and 4.13 for the concrete items on List 3. The concrete and abstract items were also equated on the number of syllables. A random order was created for each list with the restrictions that six concrete and six abstract items appeared in each half of the list and that no more than three items of one type appeared successively.

After the last list item was presented, participants were given instructions for the Salthouse and Babcock (1991) Pattern Comparison Test described in Experiment 1. The instructions along with the one 30-s test took about 1 min. Next, participants were asked to orally recall all of the items, and they were given 3 min to recall. All participants were seated in front of a computer monitor. For participants in the closed-eye condition, the computer screen was blank, and they were told to keep their eyes closed during the entire recall period. Participants in the distraction condition were asked to keep their eyes open and to look at the center of the computer screen throughout the recall period. In contrast to the series of still frames used in Experiment 1, this distraction condition consisted of multicolored sets of dots in constant spiral motion that created forms of various shapes. This distraction was created with a screen saver program. To encourage compliance with the instructions, all participants were alerted to the mirror above their heads; they were asked to make eye contact with the experimenter, who sat directly behind each participant. As in Experiment 1, there was nearly total compliance, as only 1 participant had to be reminded to comply with the instructions.

Results

The alpha level was again set at .05. We tabulated the proportion of concrete and abstract items recalled and submitted these to a 2 × 2 × 2 mixed ANOVA that included the between-subjects variables of age (younger, older) and distraction condition (closed-eye, distraction) and the within-subjects variable of type of item (concrete, abstract). As can be seen in Figure 2, concrete items were better recalled than abstract items, $F(1, 44) = 14.98$, $MSE = 0.02$, and recall was higher for younger adults relative to older adults, $F(1, 44) = 16.97$, $MSE = 0.03$. The advantage of concrete items held across all conditions, and no interactions involving concreteness approached significance (all Fs < 1).

As expected, there was a reliable main effect of the distraction condition, $F(1, 44) = 6.78$, $MSE = 0.03$, and this indicated that recall was higher in the closed-eye condition ($M = .39$, $SD = .15$) relative to the distraction condition ($M = .29$, $SD = .15$). Importantly, there was no evidence that the benefits of closing the eyes were greater for older adults, $F(1, 44) = 1.40$, $MSE = 0.03$. Indeed, as can be seen in Figure 2, the benefits of closing the eyes were actually nominally greater for younger adults ($M = .14$) than for older adults ($M = .05$).

One problem in interpreting this pattern is that the overall recall levels were much higher for younger adults. Two sets of results, however, argue against the possibility that age differences in recall masked increased benefits of gaze aversion for older adults. First, the proportional increase that resulted from closing the eyes was actually greater for younger adults (.41) relative to older adults (.22). Second, because we included both concrete and abstract items in our list, our design allowed us to nearly equate recall levels for

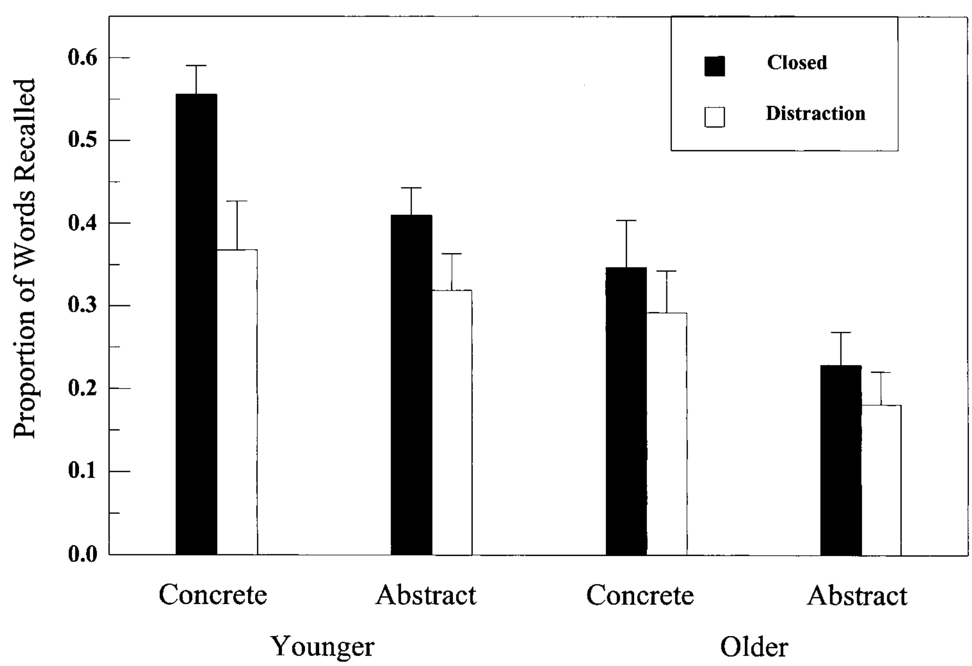

Figure 2. Mean proportion of items recalled as a function of distraction, concreteness, and age (error bars represent the standard error of the mean).

younger and older adults by comparing the recall levels of the abstract items for the younger adults (M = .37) with those for the concrete items for the older adults (M = .32). As can be seen in the middle two groups of bars in Figure 2, the recall of younger adults increased from .30 in the distraction condition to .41 in the closed-eye condition (a proportional increase of .37). By comparison, for older adults the increase was from .29 in the distraction condition to .35 in the closed-eye condition (a proportional increase of .21). Thus, even with roughly equal recall levels, younger adults showed nominally greater benefits of closing the eyes.

General Discussion

The present results both support and extend Glenberg and colleagues' (1998) work on the benefits of gaze aversion. Consistent with their results, we found that reducing distraction (by focusing on a simple stimulus as opposed to a complex stimulus) improves memory. By including a closed-eye condition in addition to the simple and complex distraction conditions in Experiment 1, we further found that there is nothing inherently important about closing the eyes per se. Instead, as proposed by Glenberg and associates, the benefit of closing the eyes seems to be due to reducing the effects of distraction and thereby allowing increased cognitive resources to be devoted to the memory task.

Important for present purposes, we extended Glenberg and colleagues' (1998) findings by showing that older adults, like younger adults, benefit from reducing distraction. From the general theoretical perspective that older adults have difficulty inhibiting the entrance of irrelevant information into working memory (Hasher & Zacks, 1988), we expected that older adults would have problems ignoring complex environmental stimulation and thus would benefit greatly from closing their eyes or focusing on a simple constant stimulus. Contrary to this prediction, the results of both experiments showed spared inhibitory functioning for older adults as there were similar benefits of gaze aversion for younger and older adults. Thus, the present results, along with those of other researchers (e.g., Schooler et al., 1997) suggest that inhibitory processes may not deteriorate markedly with increasing age.

Given the strong evidence for at least some types of age-related decrements in inhibitory processing (Earles et al., 1997; Hasher et al., 1999; Verhaeghen & DeMeersman, 1998; Zacks & Hasher, 1994), however, we prefer the interpretation that certain kinds of inhibitory functioning remain intact in older adulthood (Hasher et al., 1999; Kramer et al., 1994). As proposed by Hasher and colleagues, it seems that the capacity to inhibit visual information appearing in fixed locations is spared (Carlson et al., 1995; Connelly & Hasher, 1993; Verhaeghen & DeMeersman, 1998). Previous findings have shown spared inhibitory ability for location in older adults (Connelly & Hasher, 1993) and that older adults can ignore columns or lines of text as well as younger adults (Carlson et al., 1995). In this context, our results, using large and rather complex stimuli appearing in fixed locations, provide impressive additional evidence for this view. Moreover, to the extent that our distraction conditions approximated the kinds of visual distractions that actually occur during real-world encoding and retrieval, our results suggest that older adults are not especially affected by ambient visual distractions.

Another possible explanation of our failure to find age-related deficits in sensitivity to distraction is related to the fact that our encoding task (presented auditorially) and distraction (presented visually) were presented in different modalities; see Appendix, Note 2. Regardless of age, it may be the case that it is primarily resources specific to a visual subsystem (e.g., visuospatial sketch pad) that are occupied by visual distraction, and perhaps this minimizes or masks any age-related deficits in inhibition when the learning materials are presented auditorially. According to this view, if the distraction were presented in the same modality as the to-be-learned material, then age-related inhibitory deficits would be more pronounced and older adults would show a greater benefit of gaze aversion.

Given the paucity of research examining the influence of genuinely extraneous distraction on cognition, further research comparing the effects of gaze aversion on same and different modality distraction would be useful. It is also important to realize that our distraction conditions did not sample the entire range of the stimulus complexity dimension, and it may be the case that older adults would show greater benefits of gaze aversion (than younger adults) with more complex stimuli such as live or movie action. Similarly, older adults may be more sensitive to distracting material that is similar in nature to the learning material (i.e., when both the learning and distracting material consist of words; see Kausler & Kleim, 1978, and Verhaeghen, Vandenbroucke, & Dierckx, 1998, for different results under these conditions). Along these lines, and especially given the general impression that older adults are more sensitive to distraction than younger adults, we echo Park's (1992) call for more "research on age differences in the effects of truly irrelevant distraction on various component behaviors of cognition" (p. 462).

One caveat regarding our results is that it may be that age-related decrements in inhibition are very small and our experiments may not have been sufficiently sensitive to detect them. Our rather large sample sizes in Experiment 1 (36 younger and 36 older participants when collapsed over encoding and retrieval conditions) and our replication of no effect in Experiment 2 argue against this possibility. Also arguing against this interpretation were our findings in both experiments that, if anything, the nominal and proportional benefits of gaze aversion were larger for younger adults. Nonetheless, given that this is the first published research examining age differences in the benefits of gaze aversion, it is still possible that there are subtle age-related differences in susceptibility to the kinds of distraction used in these experiments. What seems clear, however, is that possibly small age-related decrements in negative priming do not translate into gross age-related deficits in sensitivity to the kinds of distraction used in the present research.

Our results also extend those of Glenberg and colleagues (1998) in showing that gaze aversion facilitates encoding as well as retrieval for both younger and older adults. To the extent that divided attention results can be applied to situations in which participants try to ignore distraction, we expected that the beneficial effects of gaze aversion would be larger at encoding than at retrieval (Craik et al., 1996) and that older adults would be disproportionately affected by distraction at encoding (Park et al., 1989). However, there was no evidence for these patterns. Our findings were probably due to the lack of emphasis placed on processing the distraction in our research relative to divided attention studies. Our results showed that when the emphasis is completely on the memory task such that participants attempt to ignore visual distraction, the distracting effects are similar for encoding and retrieval. Thus, although encoding and retrieval processes may differ in the extent to which they are under conscious control (Craik et al., 1996), they are similarly affected when the task demands discourage processing of the distracting materials.

The magnitude of the benefits of gaze aversion varied across our two experiments. Collapsed across the conditions of Experiment 1, closing the eyes and focusing on a simple stimulus led to a modest absolute increase in recall of 6.0% in comparison to the complex distraction condition, and this represents a relative increase of approximately 12.5%. In Experiment 2, the benefits of gaze aversion were more pronounced and produced an absolute increase of 9.5% and a relative increase of 32.8%. (These compare with an absolute increase of 5% and a relative increase of 20% in Experiment 5 of Glenberg et al., 1998.) The apparently larger effects in Experiment 2 may have been due to using a retrieval task (free recall) that is more sensitive to distracting influences (Craik et al., 1996) and/or to using more dynamic distraction. Given the other differences between the experiments, however, these possibilities remain speculative at this point. Nonetheless, these results suggest that certain materials and tasks may be especially sensitive to distraction, and we believe that further research aimed at examining these conditions has both practical and theoretical interest.

Like Glenberg and colleagues (1998), we believe that gaze aversion can have some benefits on cognitive processing. As proposed by Glenberg and colleagues, it appears that we are normally engaged in the environment in the sense that some of our cognitive resources are devoted to processing fluid environmental conditions. Disengaging from environmental control appears to free up some cognitive resources, and our research shows that this has mnemonic benefits. In terms of practical value, gaze aversion seems to be a relatively simple way of reducing environmental distraction during encoding and retrieval and boosting memory performance for both older and younger adults.

Acknowledgments

This project was supported in part by National Institute on Aging Grant AG05627 and by National Aeronautics and Space Agency Grant NCC-2-1085. We thank Mark McDaniel for comments and suggestions on a draft of this article and Don Lineback for helping us create the word lists.

Address correspondence to Gilles O. Einstein, Department of Psychology, Furman University, Greenville, SC 29613. E-mail: gil.einstein@furman.edu

References

Anderson, N. D., Craik, F. I. M., & Naveh-Benjamin, M. (1998). The attentional demands of encoding and retrieval in younger and older adults: Evidence from divided attention costs. *Psychology and Aging*, *13*, 405–423.

Carlson, M. C., Hasher, L., Connelly, S. L., & Zacks, R. T. (1995). Aging, distraction, and the benefits of predictable location. *Psychology and Aging*, *10*, 427–436.

Connelly, S. L., & Hasher, L. (1993). Aging and inhibition of spatial location. *Journal of Experimental Psychology: Human Perception and Performance*, *19*, 1238–1250.

Connelly, S. L., Hasher, L., & Zacks, R. T. (1991). Aging and reading: The impact of distraction. *Psychology and Aging*, *6*, 533–541.

Craik, F. I. M. (1986). A functional account of age differences in memory. In F. Klix & H. Hangendorf (Eds.), *Human memory and cognitive capabilities: Mechanisms and performances* (pp. 409–422). Amsterdam: Elsevier.

Craik, F. I. M., Govoni, R., Naveh-Benjamin, M., & Anderson, N. D. (1996). The effects of divided attention on encoding and retrieval processes in human memory. *Journal of Experimental Psychology: General*, *125*, 159–180.

Earles, J. L., Connor, L. T., Frieske, D., Park, D. C., & Smith, A. D. (1997). Age differences in inhibition: Possible causes and consequences. *Aging, Neuropsychology, and Cognition*, *4*, 45–57.

Glenberg, A. M. (1997). What memory is for. *Behavioral & Brain Sciences*, *20*, 1–19.

Glenberg, A. M., Schroeder, J. L., & Robertson, D. A. (1998). Averting the gaze disengages the environment and facilitates remembering. *Memory & Cognition*, *26*, 651–658.

Hasher, L., Stoltzfus, E. R., Zacks, R. T., & Rypma, B. (1991). Age and inhibition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *17*, 163–169.

Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. In G. Bower (Ed.), *The psychology of learning and motivation* (pp. 193–225). New York: Academic Press.

Hasher, L., Zacks, R. T., & May, C. P. (1999). Inhibitory control, circadian arousal, and age. In D. Gopher & A. Koriat (Eds.), *Attention and performance XVII* (pp. 653–675). Cambridge, MA: MIT Press.

Kausler, D. H., & Kleim, D. M. (1978). Age differences in processing relevant versus irrelevant stimuli in multiple item recognition learning. *Journal of Gerontology*, *33*, 87–93.

Kramer, A. F., Humphrey, D. G., Larish, J. F., Logan, G. D., & Strayer, D. L. (1994). Aging and inhibition: Beyond a unitary view of inhibitory processing in attention. *Psychology and Aging*, *9*, 491–512.

May, C. P., & Hasher, L. (1998). Synchrony effects in inhibitory control over thought and action. *Journal of Experimental Psychology: Human Perception and Performance*, *24*, 363–379.

Neill, W. T., Valdes, L. A., & Terry, K. M. (1995). Selective attention and the inhibitory control of cognition. In F. N. Dempster & C. J. Brainerd (Eds.), *New perspectives on interference and inhibition in cognition* (pp. 207–261). New York: Academic Press.

Palermo, D. S., & Jenkins J. J. (1964). *Word association norms.* Minneapolis: University of Minnesota Press.

Park, D. C. (1992). Applied cognitive aging research. In. F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (pp. 449–493). Hillsdale, NJ: Erlbaum.

Park, D. C., Smith, A. D., Dudley, W. N., & Lafronza, V. N. (1989). Effects of age and a divided attention task presented during encoding and retrieval on memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *15*, 1184–1191.

Park, D. C., Smith, A. D., Morrell, R. W., Puglisi, J. T., & Dudley, W. N. (1990). Effects of contextual integration on recall of pictures by older adults. *Journal of Gerontology: Psychological Sciences*, *45*, P52–P57.

Raven, J. C. (1965). *Mill Hill Vocabulary Scale*. London: H. K. Lewis.

Salthouse, T. A., & Babcock, R. L. (1991). Decomposing adult age differences in working memory. *Developmental Psychology*, *27*, 763–776.

Schooler, C., Neumann, E., Caplan, L. J., & Roberts, B. R. (1997). Continued inhibitory capacity throughout adulthood: Conceptual negative priming in younger and older adults. *Psychology and Aging*, *12*, 667–674.

Sullivan, M. P., & Faust, M. E. (1993). Evidence for identity inhibition during selective attention in old adults. *Psychology and Aging*, *8*, 589–598.

Tipper, S. P. (1991). Less attentional selectivity as a result of declining inhibition in older adults. *Psychonomic Society Bulletin*, *29*, 45–47.

Tipper, S. P., Weaver, B., Cameron, S., Brehaut, J. C., & Bastedo, J. (1991). Inhibitory mechanisms of attention in identification and localization tasks: Timecourse and disruption. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *17*, 681–692.

Toglia, M. P., & Battig, W. F. (1978). *Handbook of semantic word norms.* Hillsdale, NJ: Erlbaum.

Verhaeghen, P., & DeMeersman, L. (1998). Aging and the negative priming effect: A meta-analysis. *Psychology and Aging*, *13*, 435–444.

Verhaeghen, P., Vandenbroucke, A., & Dierckx, V. (1998). Growing slower and less accurate: Adult age differences in time-accuracy functions for recall and recognition from episodic memory. *Experimental Aging Research*, *24*, 3–19.

Zacks, R. T., & Hasher, L. (1994). Directed ignoring: Inhibitory regulation of working memory. In D. Dagenbach & T. H. Carr (Eds.), *Inhibitory processes in attention, memory, and language* (pp. 241–264). San Diego, CA: Academic Press.

Received December 7, 1999
Accepted October 30, 2000
Decision Editor: Toni C. Antonucci, PhD

Appendix

Notes

1. For ease of exposition, these data were collapsed across lists. A $2 \times 2 \times 3 \times 2 \times 2$ ANOVA that included lists as a variable revealed that performance was significantly higher on the second list (for both younger and older adults), but there were no significant interactions involving lists.
2. We thank an anonymous reviewer for pointing this out.