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Age and Reading: The Impact of Distraction

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Older and younger adults read aloud and answered questions about texts that did or did not have distracting material interspersed amid target text. When present, distracting material occurred in a different type font from that of target material. Across 2 experiments, distracting material was meaningless, meaningful but unrelated to the text, or meaningful and text related. Subjects were instructed to attend only to the target text. Reading time measures indicated that compared with younger adults, older adults have a more difficult time ignoring the distracting information, particularly information meaningfully related to target text. Verbal ability differences among older, but not younger, adults moderated distraction effects. Age differences in inhibitory attentional mechanisms were considered as processes influencing distraction effects.

There is considerable evidence in the cognitive gerontology literature to suggest the existence of an age deficit in at least some aspects of selective attention (see Hoyer & Plude, 1980, 1982; but see also Madden, 1990). In particular, age deficits seem to be pronounced under divided attention or search conditions in which the location of target information is not predictable. Age differences are less apparent under nonsearch or focused attention conditions (Plude & Hoyer, 1985). Especially under the former conditions, older adults are less able than younger adults to maintain the focus of attention on strictly task-relevant information and are more easily distracted by the presence of irrelevant information in a display (e.g., Cremer & Zeef, 1987; Layton, 1975; Rabbitt, 1965, 1968).

Hasher and Zacks (1988) have recently proposed a general processing model that may be helpful in understanding performance deficits seen when older adults are called on to process information in the presence of distraction. Building on the work of attention theorists such as Navon (1989) and O. Neumann (1984), the framework assumes an attentional suppression (or inhibition) mechanism that controls the negative impact that distracting stimuli and thoughts can have on the processing of task-relevant information. In particular, this mechanism serves to dampen the activation of task-irrelevant thoughts or representations, whether such activation is a direct (i.e., data-driven) consequence of the presence of irrelevant stimuli in the task environment or has a more internal source (e.g., is produced by spreading activation or associative connections). To the degree that inhibition functions effectively, distracting stimuli and thoughts will not interfere significantly with the processing of task-relevant information. On the other hand, to the degree that inhibitory processes are deficient, the suppression of task-irrelevant mental representations will be delayed and there will be increased interference with task-relevant processing. In line with this way of thinking, Hasher and Zacks (1988) suggested that there is an age-related decline in the ability to suppress task-irrelevant processing that could account for at least a significant proportion of the cognitive deficits associated with aging.

Direct evidence for the operation of the proposed suppression mechanism in the behavior of younger adults has been found in selective attention tasks in which a previously irrelevant, or distracter, stimulus becomes the relevant, or target, item on the subsequent trial (e.g., Lowe, 1985; Neill, 1977, 1979; E. Neumann & DeSchepper, 1991; Tipper, 1985; Tipper & Cranston, 1985). Younger adults are slower to name the current target item if it had served as a distracter on the preceding trial than if the current target had not occurred on the preceding trial. Suppression effects have now been reported (for young adults at least) across an array of stimuli ranging from letters to words to pictures of objects. Such findings have been taken as evidence that the selection of a target item can entail the active suppression of distracters. By contrast, several studies have been reported in which no suppression effect (or "negative priming") was found for older adults (Hasher, Stoltzfus, Zacks, & Rypma, 1991; see also McDowd & Oseas, in press; Stoltzfus, Hasher, Zacks, Ulivi, & Goldstein, 1991; Tipper, 1991).

These data suggest that older adults do not inhibit response tendencies to irrelevant stimuli as strongly as younger adults do. Although most of the tasks cited thus far have been tied to the visual selective attention literature and therefore have used relatively simple stimuli, it seems reasonable to expect that this reduction in the ability to ignore irrelevant stimuli would be

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evident with more complex information-processing tasks. A supportive example is Kausler and Kleim's (1978) finding that the performance of older adults on a multiple-item recognition task is disproportionately impaired by an increase in the number of irrelevant stimuli.

Similar effects may be expected to occur in everyday situations. Consider reading the daily newspaper, or a weekly news magazine. In both instances, the choice of one article entails ignoring other articles, photographs, advertisements, or announcements that appear in close proximity on the same page. If suppression mechanisms are deficient, older adults may have greater difficulty than younger adults in focusing on a target story to the exclusion of other visually available information.

In the present experiments we compared the ability of younger and older adults to ignore irrelevant information in the context of a task that required participants to read connected discourse that, on experimental trials, occurred along with distracting information. To do this, we used a variant of a visual divided attention task (Willows & MacKinnon, 1973). In the present version, subjects read a passage that either did or did not contain distracting text interspersed amid the target text. Target text and distracting text were discriminable on the basis of type font (italics and standard, respectively). Two assessments of distraction were used: reading time and comprehension. We anticipated that older adults would be less able to ignore the interspersed irrelevant material and, as a result, would read more slowly and show poorer comprehension than younger adults.

Experiment 1

Method

Subjects. Twenty-four younger (M age = 18.83, SD = .87) and 24 older (M age = 68.75 years, SD = 3.23) adults participated in this study. As part of a questionnaire administered to each subject, all 24 of the young subjects and 23 of the 24 older participants indicated that they considered their health to be good or better than average. The young adults were students enrolled in an introductory psychology course who received research credit for a course requirement in return for their participation. The older adults were recruited from the subject pool maintained by the Duke University Center for the Study of Aging and Human Development. The older adults were paid $10 for their participation and were reimbursed for parking expenses.

Design. The performance of younger and older adults was compared on a task that required subjects to read a series of passages aloud and answer questions about their content. There were two presentation conditions: (a) experimental, in which distracting material was printed between the words of the story (see Appendix for an example); and (b) control, in which no distracting material occurred. All subjects read six passages of each type, blocked in a series. The design was a 2 (Ages) × 2 (Reading Conditions) mixed factorial, with the latter variable tested within subjects.

Materials. Fourteen stories, each approximately 125 words in length, were used as materials.[1] In both the experimental and the control conditions, the text of the story was printed in italics (Jetware Laserjet 4inl Courier 10 Italic). Distracting words, which appeared only in the experimental version of a passage, were printed in a standard font (Jetware LaserJet 4inl Courier 10) interspersed among the words of the story (see Appendix). The distracters consisted of four different words or short phrases, each of which was meaningfully related to the text of the story. Each distracter word or phrase appeared 15 times, for a total of 60 distracting items per story. These were positioned such that no word or phrase followed itself immediately. On average, an interruption occurred every four to five text words. Each story (whether with or without distracters) was printed on one 8½ × 11 in. sheet of paper.

Four multiple-choice comprehension questions were prepared for each story (see Appendix for an example). The four questions and their potential answers were presented on a separate sheet of paper and were printed in a third font (Jetware Laserjet 4inl Letter Gothic 12). Each question had six possible answers—one that was correct, one that served as a distracter on experimental versions of passages (a foil), and four others that were plausible answers to the questions but were unrelated to the particular story.

Procedure. All subjects were tested individually. Before beginning the experiment proper, each participant was informed about the two tasks. The first was to read a series of passages aloud. The second was to answer four multiple-choice comprehension questions that would immediately follow each story. Subjects were told that their reading would be tape recorded, and so they should read clearly and accurately while also trying to remember what they read so that they would be able to answer the comprehension questions. Each story was introduced by the experimenter, who placed it facedown in front of the subject. The experimenter then cued the subject to turn the paper over and read aloud, beginning with the title. Subjects were not allowed to follow along with a marker (e.g., a finger) while reading. At the end of a story, the subject turned the page facedown and exchanged it for the page containing the multiple-choice questions. Subjects were told to circle the best answer to each question, and did so at their own pace.

The formal task began with a practice trial in which subjects read a passage conforming to a control version and then answered the subsequent comprehension questions. After the practice trial, half of the subjects in each age group read a series of six control stories, followed by six experimental stories. The remaining subjects read six experimental stories followed by six control stories. Before the introduction of the first experimental passage, subjects were informed of the presence and appearance (type format) of the distracting material. They were told to completely ignore this text, and to read only the text printed in italics. Following the comprehension test for the sixth experimental story, a seventh experimental story served as a catch trial. Immediately after reading the seventh story, subjects were given a surprise distracter recall test. They were asked to write down any of the distracter words or phrases they could recall from the most recent story. This was intended as an additional measure of the degree to which subjects were successful at ignoring distracting information.

Subjects thus read 14 stories in all: 6 control, 6 experimental, 1 practice, and 1 catch-trial passage. The practice and catch-trial stories were the same for all subjects. The remaining 12 stories were counterbalanced across conditions so that each served equally often in control and experimental conditions. Within each condition there were two different orders of the stories, and these were used equally often. The Wechsler Adult Intelligence Scale—Revised (WAIS–R; Wechsler, 1981) Vocabulary subtest was administered as a measure of verbal ability after the reading task.

Results and Discussion

Subject comparisons. For all analyses, except where noted, the alpha level was set at .025. The older subjects had more years of education (M = 14.75, SD = 2.21) than the younger subjects (M = 12.88, SD = 1.12), $t(46)$ = 3.71. Older and younger

[1] We are grateful to Gabriel A. Radvansky for providing these materials.

subjects did not differ in their Vocabulary scores ($M = 55.3$ and $M = 53.9$, respectively),[2] $t(46) < 1$.

Reading time. Mean reading times for the six experimental and six control stories are shown in Figure 1.[3] These values were subjected to a 2 × 2 mixed-design analysis of variance (ANOVA), with age as the between-subjects variable and passage type (experimental vs. control) the within-subjects variable. Overall, older subjects read more slowly than younger subjects, $F(1, 46) = 54.48$, $\omega^2 = .176$, and experimental passages were read more slowly than control passages, $F(1, 46) = 143.33$, $\omega^2 = .351$. As well, the interaction depicted in Figure 1 is reliable, $F(1, 46) = 32.23$, $\omega^2 = .077$. Thus, although both older and younger adults are impeded when distracting text material is physically present, the disruption to reading time from distraction is substantially greater for older than for younger participants.

One potential source of the greater difficulty experienced by older adults might lie with the disruptive effects of the first few experimental stories. Perhaps older adults adjust to this unusual set of stimuli more slowly than younger adults. To assess this, reading time was reanalyzed to include passage position (first through sixth) as a variable (see Figure 2 for these means). The highest order interaction among age, passage condition, and passage position was reliable, $F(5, 230) = 2.57$, $\omega^2 = .001$. Inspection of this interaction revealed that for young adults, the interaction between passage condition and passage position was not significant, $F < 1$. Reading time was essentially constant within the sequence of six experimental stories and within the sequence of six control stories.

By contrast, the interaction between passage condition and position was significant for older adults, $F(5, 115) = 2.73$, $\omega^2 = .002$. This interaction was due to the presence of practice effects for experimental passages but not for control passages; the latter were read about equally fast across the series. A Newman-Keuls test on the experimental stories (with alpha set at .05) revealed an improvement in reading time from the first to the third story but no reliable differences thereafter. It is important to note that this practice effect does not mitigate the conclusion that the disruptive effect of distraction is greater for older than for younger adults. Indeed, an analysis done on younger and

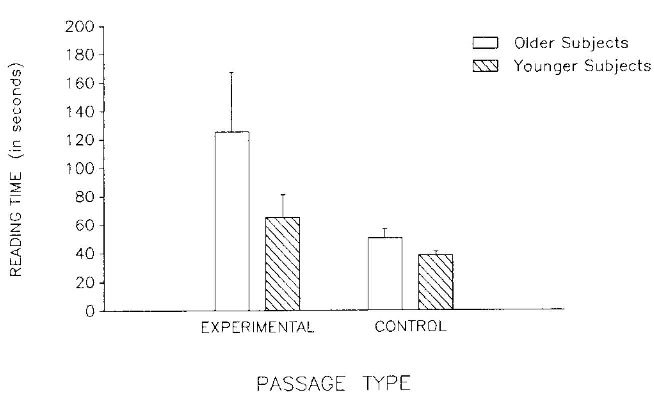

Figure 1. Mean reading times in Experiment 1 on control and experimental passages for younger and older adults. (Error bars indicate one standard deviation.)

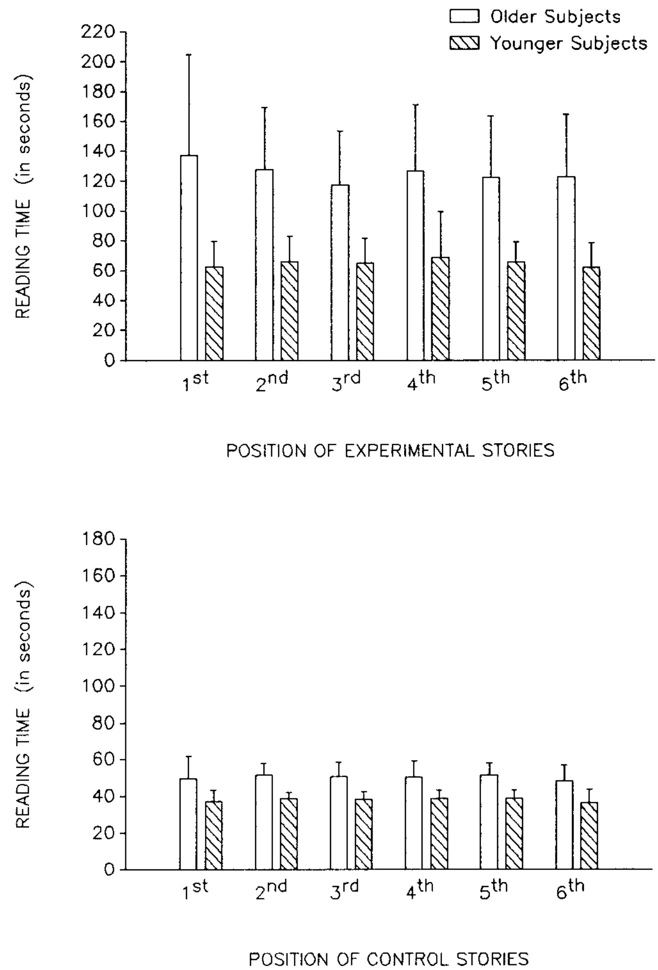

Figure 2. Mean reading times in Experiment 1 on control and experimental passages across story presentation order of younger and older adults. (Error bars indicate one standard deviation.)

older adults' reading time for experimental and control passages that served in the sixth position in the testing series reveals the same pattern for the critical Age × Passage Type interaction as seen earlier for all six stories, $F(1, 46) = 31.54$, $\omega^2 = .078$. Thus, even after practice effects have leveled off, the read-

[2] The Wechsler Adult Intelligence Scale—Revised scores reported here are underestimates of actual performance because the experimental protocol accidentally omitted the standard procedure of probing subjects when an initial attempt did not produce a correct definition of a word. Both younger and older adults received this same nonstandard administration of the test, and so age comparisons are not affected.

[3] As far as we know, there has been little systematic study of adult age differences in reading aloud rates. One study that did measure this variable (Moscovitch, Winocur, & McLachlan, 1986, Experiment 2) found reading rates for both younger and older adults that were considerably slower than those we obtained in the control condition. The materials in the Moscovitch et al. research were unrelated five-word sentences presented under visually degraded conditions, as compared with the continuous prose and clear viewing conditions used in the present research.

ing time of older adults is clearly more slowed by the presence of distracting text than is that of younger adults.[4]

Comprehension performance. The mean number of correct answers (out of a maximum of four for each passage) are shown in Table 1. Younger subjects selected the correct answer more often than did older adults, $F(1, 46) = 9.41$, $\omega^2 = .051$. As well, more correct answers were selected after reading control passages than after reading experimental passages, $F(1, 46) = 57.42$, $\omega^2 = .187$. The interaction between age and passage type was not significant, $p > .2$. Thus, distracting material reduces performance, as measured by number correct on a multiple-choice recognition test, but there is only a nonsignificant trend in the direction of a greater disruption effect on the part of older adults.

Because there were age and passage condition differences in number correct, foil errors (those in which the subject chose, as the correct answer, an item that served as a distracter during presentation of the experimental versions of passages) were computed as a proportion of the total possible errors each subject could make. The means for each condition are shown in Table 1. The only significant effect in these data is that foil errors were more likely to occur after an experimental story than after a control story, $F(1, 46) = 28.99$, $\omega^2 = .178$. Neither the main effect of age nor the interaction between age and passage type was significant, $Fs < 1$. Thus, younger and older adults are about equally likely to select distracting material as the wrong answer to a multiple-choice comprehension question. The apparently different effects of distraction on reading time versus on foil errors are discussed later.

Catch-trial analysis. Data from the catch trial were scored for the number of foil words or phrases recalled. The maximum possible was four. Recall was near the floor for both younger ($M = .79$ foils) and older subjects ($M = .42$). This difference was not significant ($t = 1.67$, $p > .05$); however, given the low level of recall, very little can be made of this result.

Verbal ability. A final set of analyses considered the contribution of verbal ability to performance and especially to age differences. One impetus for these analyses was the somewhat greater variability in WAIS–R Vocabulary scores among older ($SD = 8.92$) than among younger adults ($SD = 7.42$). First, analyses of covariance (ANCOVAs) with Vocabulary score as the covariate were carried out on each of the dependent measures discussed earlier. In each case, the ANCOVA results replicated the ANOVA results already described in terms of significant and nonsignificant effects.

Second, within each age group, WAIS–R Vocabulary score was correlated with the reading time distraction measure (the difference between mean reading times for experimental and control passages) and with performance on the comprehension test. None of the correlations with the comprehension measures was significant. Vocabulary and the distraction effect in reading showed a moderate but unreliable negative relationship for young adults, $r = -.303$, $p = .15$. For older adults, however, lower verbal ability was reliably associated with a greater distraction effect, $r = -.545$. Note that verbal ability accounts for 30% of the variance in slowed reading shown by older adults but only 9% of the variance for younger adults.

In summary, then, this experiment has shown that for both younger and older adults, reading time is slowed by the presence of interspersed, extraneous material in the text. Such material also lowers comprehension by reducing number correct and by increasing foil errors. Although both older and younger adults are disrupted by the presence of distracting material, the impact, as assessed by reading time, is clearly greater for older adults. The comprehension data do not reveal a significant age difference in the impact of distraction, but older adults perform more poorly overall.

Also, for older—but not for younger—adults, susceptibility to distraction is increased for participants with lower verbal ability. A similar pattern, with verbal ability having a greater impact with aging, has been reported elsewhere in the discourse processing literature (Cavanaugh, 1983; Cohen, 1979; Zacks, Hasher, Doren, Hamm, & Attig, 1987; Zelinski & Gilewski, 1988; but see also Hultsch, Hertzog, & Dixon, 1990).

Experiment 2

In Experiment 2, we considered the question of whether the content of distracting information plays an important role in determining disruption effects. Two distinct possibilities occurred to us. It could be that the simple presence of distracting information (independent of its semantic content) was enough to account for the dramatic slowdown in reading time shown by older adults in the first experiment. That is, just needing to cover the physical distance across disruptions in the connected discourse may have slowed subjects' reading times. If this were the case, participants might be slowed as much by the presence of nonsemantic information as they are by semantic information. As a test of this hypothesis, the distracting words from Experiment 1 were replaced with matched-length strings of *x*s in one condition of the present experiment.

We also noted that the distracting information used in Experiment 1 was not just generally meaningful, but the words and phrases used were actually related to events discussed in the target passages. Perhaps it is this particular relationship between target and distracting information that is difficult for older adults, rather than the simple presence of extraneous words and phrases. To investigate this possibility, we replaced, in another condition of this experiment, the text-related distracters from Experiment 1 with meaningful words or short phrases that were not relevant to the target text. The two basic conditions from Experiment 1, text-related distracters (previously called experimental) and control (with no distracters), were also included here.

Method

Subjects. Thirty-two younger (M age = 18.5 years, $SD = 1.14$) and 32 older (M age = 68.3 years, $SD = 3.29$) adults participated in this study.

[4] An analysis of the errors made by subjects while reading the passages revealed misreadings of several types, including hesitations, intrusions of foil words, saying the wrong word, and omitting a word. Beyond showing that the older adults produced somewhat more reading errors overall, this analysis was relatively uninformative about the causes of the age differences in distraction effects. We attribute this to the fact that the frequency of misreadings was quite low in both groups (an average of less than 1.5 errors per subject per passage in the older group), with the consequence that the analysis was insensitive to age differences in the pattern of errors.

Table 1
Mean Number Correct and Mean Proportion of Foil Errors per Passage for Younger and Older Adults on Experimental and Control Passages: Experiments 1 and 2

Age group	Passage							
	Related[a]		Unrelated[b]		x-string[b]		Control	
	Correct	Foil	Correct	Foil	Correct	Foil	Correct	Foil
Experiment 1								
Young	3.15	.78					3.56	.44
Old	2.80	.81					3.37	.49
Experiment 2								
Young	3.07	.70	3.55	.37	3.33	.32	3.36	.34
Old	2.46	.70	3.14	.33	3.06	.51	3.09	.47

[a] In Experiment 1, this condition was called *experimental.* [b] Conditions present in Experiment 2 only.

In response to a question about their perceived health, 93.8% of the younger subjects and 87.5% of the older subjects reported their health as good or better than average. Both groups were recruited from the same sources as in the first experiment, and no person served in both.

Design. As in Experiment 1, the performance of younger and older adults was compared on a task that required subjects to read a series of passages aloud and answer questions about their content. Now there were four types of passages, one control condition and three experimental (text-related, text-unrelated, and meaningless) conditions; all three experimental conditions had distracting material printed amid the words of the story. The design was thus a 2 (Ages) × 4 (Reading Conditions) mixed factorial, with passage conditions tested within subjects.

Materials. The 13 (12 critical and 1 practice) original stories and multiple-choice questions from Experiment 1 were used again, as were the text-related distracters. The other two experimental conditions were yoked to this original condition, as follows. Text-unrelated fillers were created by replacing the original materials with words and phrases matched for frequency of occurrence (Kucera & Francis, 1967) and word length with the original text-relevant distracters. In the meaningless condition, the original positions that the text-related distracters occupied were replaced by strings of *x*s of matched length.

There were now three stories of each type (control, text related, text unrelated, and meaningless) presented to subjects in blocks. The order of these conditions was counterbalanced across subjects such that each condition served in each of the four possible positions equally often for both younger and older subjects. As well, stories were counterbalanced across conditions such that each story served equally often in each of the four main conditions of the experiment.

Procedure. The procedure was the same as that in Experiment 1, with a few exceptions noted here. The catch trial was eliminated from the procedure. Also, the Extended Range Vocabulary Test (ERVT; Educational Testing Service, 1976) was used as a measure of verbal ability because of its considerable brevity and ease of administration compared with the Vocabulary subtest of the WAIS-R. The ERVT is a multiple-choice test that is thought to be more sensitive to higher ranges of verbal ability than is the WAIS–R Vocabulary subtest.

Results and Discussion

Subject comparisons. The older subjects had more years of education ($M = 14.4$, $SD = 2.94$) than the younger subjects ($M = 12.4$, $SD = 0.88$), $t(62) = 3.63$. The vocabulary scores of older adults ($M = 25.3$) did not differ from those of the younger subjects ($M = 25.6$), $t(62) < 1$.

Reading time. The time taken for each subject to read the three passages in each condition was determined and averaged to create one score for control passages and one score for each of the three types of experimental passages (see Figure 3). The data were subjected to a 2 × 4 mixed-design ANOVA, with age the between-subjects variable and trial type the within-subjects variable. As in the first experiment, older adults read more slowly than did younger adults, $F(1, 62) = 79.67$, $\omega^2 = .204$. There were also differences among the four story conditions, $F(3, 186) = 146.43$, $\omega^2 = .323$. These differences are best understood in light of the significant interaction between age and passage type, $F(3, 186) = 32.73$, $\omega^2 = .071$. As can be seen in Figure 3, the basic finding from Experiment 1 is replicated: Older adults are more slowed by text-related distracting material than are younger adults.

Newman-Keuls tests were done separately on older and younger adults' performance in the four reading conditions, with alpha set at .05. Older adults were more slowed by text-related than by text-unrelated distracters, and they were more slowed by both passages containing text as distracters than they were by passages having strings of *x*s as distracters. But even strings of *x*s slowed reading time reliably. Younger adults, too, were slowed by the presence of strings of *x*s interrupting the target text. As was true for older adults, passages with either type of text as distraction were read more slowly than those with strings of *x*s. However, younger adults were no more disrupted by text-related than by text-unrelated distracters. A final comparison contrasted the reading time difference between text-unrelated passages and *x*-string passages for younger and older adults. That difference was significant, $F(1, 62) = 32.77$, $\omega^2 = .332$. Thus, although both groups of subjects are slowed by the presence of distracting verbal information as compared with distracting visual noise (the *x*-string condition), older adults are still more slowed than are younger adults.

As in Experiment 1, the presence of differential practice effects within experimental conditions was assessed by adding story position (first through third) as a variable to the analysis of reading time. In this instance, however, the interaction among age, experimental condition, and story position was not significant, $F = 1.01$, whereas the interaction between age and passage position was significant, $F(2, 124) = 3.91$, $\omega^2 = .001$. The latter effect reflects the fact that older adults showed greater decreases in reading time across successive passages within conditions than younger adults did. A final analysis of reading speed of younger and older adults on just the third story of each condition did not alter the conclusions based on all three stories in a condition.

Comprehension performance. The number of correct answers and the proportion of errors that are foils are shown in Table 1. Correct answers will be considered first. Younger adults answered more questions correctly than did older adults, $F(1, 62) = 13.71$, $\omega^2 = .061$. The main effect of passage type was significant, $F(3, 186) = 16.41$, $\omega^2 = .096$, with passages having relevant distracters showing poorer comprehension scores than all others. The remaining conditions did not differ reliably from each other. The suggested interaction between age and passage type, which parallels the trend seen in Experiment 1, was not large enough to be reliable, $F(3, 186) = 2.34$, $p = .075$. However, the interaction was significant if only the original conditions from the first experiment (text related and control) were compared, $F(1, 62) = 4.88$, $\omega^2 = .013$.

Because of the nature of the distracting materials used in Experiment 2, there was only one condition (text relevant) in which a true foil error could occur, so only these passages were compared with the control passages in the analysis of foil errors. Overall, older and younger adults did not differ in the proportion of errors that were foils, $F = 1.11$. Foil errors were more likely following text-related passages than following control passages, $F(1, 62) = 25.17$, $\omega^2 = .109$. As in Experiment 1, no interaction was present between age and condition, $F = 1.09$.

Verbal ability. As in Experiment 1, the variability in verbal scores was greater for older ($SD = 11.11$) than for younger subjects ($SD = 6.43$). Again, ANCOVAs left unaltered all conclusions derived from the previously described ANOVAs of the reading time and comprehension measures.

Also, the within-age-group correlations with ERVT Vocabulary score were similar to those of Experiment 1. For neither age group were there reliable verbal ability correlations with comprehension test performance. For older adults only, verbal ability did predict the magnitude of distraction effects in reading time. For this group, the correlations between ERVT vocabulary score and disruption effects, as measured by subtracting control reading time from each of the three experimental reading times, were −.384, −.567, and −.403 for text-related, text-unrelated, and *x*-string conditions, respectively. Thus, verbal ability, as indexed by a vocabulary test, accounted for between 15% and 32% of the variance in older adults' slowed reading in the presence of distraction. Especially striking was the attenuation of the distraction effects for those older adults with the highest ERVT scores. In particular, for the text-related, text-unrelated, and *x*-string conditions, respectively, the top quartile of the older group had average distraction effects that were 40%, 45%, and 20% lower than those of the entire sample of older adults.

In an effort to control for the possibility that the smaller variability in ERVT Vocabulary scores among younger adults contributed to the failure of verbal ability to predict distraction effects in this group, 16 additional younger adults (M age = 19.0 years, $SD = 1.46$) from a population with lower average verbal ability than the Duke undergraduates were tested.[5] Although these new participants did, as expected, have a lower mean ERVT Vocabulary score (16.14, $SD = 5.26$) than the original young sample, there still was no relationship between verbal ability and reading distraction for all the young adults (largest $r = -.079$). However, it should be noted that our attempt to equate the variability in vocabulary scores across the two age groups was only partially successful (SD for the combined group of 48 younger subjects = 7.52). This, along with the fact that other discourse processing tasks have yielded contradictory evidence as to whether or not verbal ability relationships increase with aging (cf. Hultsch et al., 1990; Zelinski & Gilewski, 1988), suggests that it is appropriate to be cautious in interpreting the current findings. Our findings are consistent, however, with Hultsch et al.'s (1990) observation that Age × Verbal Ability interactions are more likely to be found when, as is the case for our research, the samples include high-ability older adults.

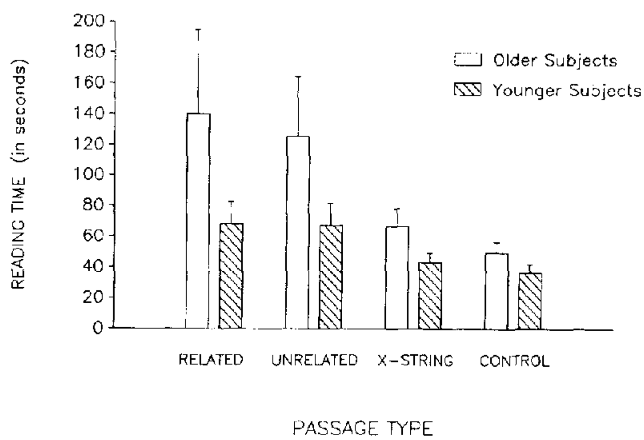

Figure 3. Mean reading times in Experiment 2 on text-related, text-unrelated, *x*-string, and control passages for younger and older adults. (Error bars indicate one standard deviation.)

General Discussion

Two experiments demonstrated that the reading of both younger and older adults is disrupted by the presence of interspersed words and phrases that are not part of the target connected discourse (see also Glanzer, Fischer, & Dorfman, 1984). The reading time results are quite clear in showing that the disruptive effect of extraneous material is far greater for older than for younger adults. Although not so convincing, comprehension accuracy data are also suggestive of age differences in disruption from extraneous material. Thus, the general pattern of findings is broadly consistent with the view that, under some circumstances, older adults are more distractible than younger adults (Layton, 1975).

The second experiment demonstrates that the degree of disruption in reading time is influenced by the nature of the relation between the target text and the distracters. In particular, semantically meaningful material, as occurs in both the text-related and text-unrelated conditions of the second experi-

[5] We thank Ellen Stoltzfus for suggesting this idea.

ment, is more disruptive to both younger and older adults than is identical space that is filled with strings of *x*s. The second experiment also reveals an additional factor influencing the degree of disruption experienced by older, but not by younger, adults: whether the distracting material is meaningfully related to the target text. When the extraneous material bears a meaningful relationship to the target text, older adults are still more slowed in their reading relative to when the extraneous material bears no meaningful relationship to the target text.

There are two possible sources of this finding. One is that the differential disruption is the product of what might be a greater breadth of spontaneous activation during reading of text for older adults than for younger adults. Some of this self-generated activation might then match the material selected by the experimenters to serve as distracters in the text-relevant conditions. This match between self-generated activation and actually occurring information might serve to slow a reader who may be considering the meaning of both messages. If the breadth of activation is more limited for younger adults than for older adults (as the Hasher & Zacks, 1988, framework suggests is the case), then fewer accidental matches would obtain between thought-about and actually presented information for younger adults than for older adults.

A second source of differential disruption might be that once physically present, text-related information might simply trigger greater attentiveness for older adults than for younger adults, with the former again expending greater effort to understand both meanings. Both possibilities are consistent with converging evidence (e.g., Gerard, Zacks, Hasher, & Radvansky, 1991; Hamm & Hasher, in press; Hartman & Hasher, 1991) suggesting that older adults suffer differentially from the activation of a larger number of thoughts than is true for younger adults. In either case, a mechanism that may ultimately be responsible for heightened disruption shown by older adults is the presumed age-related decline in the ability to suppress task-irrelevant information occurring during the selection of task-relevant information.

This view might also suggest that older adults would be expected to actually know more about the irrelevant information than younger adults. Our attempts to measure this were twofold: evaluation of the foil errors on the comprehension tests of both experiments and the unexpected distracter recall, or "catch," trial in Experiment 1. In neither case did the data support our expectation. However, hindsight suggests that neither of these measures was ideal. On the one hand, the relatively good performance on the comprehension test (the accuracy was, on average, above 75%) meant that there were relatively few opportunities for making foil errors in any particular condition. On the other hand, recall of the distracter items on the catch trial of Experiment 1 was so low that floor effects made the analysis of this measure suspect.

Additionally, both measures of subjects' knowledge of the distracting information were based on "direct" (Johnson & Hasher, 1987) or "explicit" (Schacter, 1987) memory tests.[6] If, as seems likely, any processing that was carried out on the distracter items was at a shallow or perceptual level, direct memory tests might fail to reveal differences in the amount of such processing. In fact, the use of direct memory tests may account for other failures in the literature to find evidence of superior memory for irrelevant information among older adults (e.g., Kausler & Kleim, 1978; Park, Smith, & Cherry, 1990). If so, it is possible that "indirect" or "implicit" memory tasks that impose fewer demands on direct retrieval (than is the case for recall and recognition tasks) may prove to be more sensitive measures of what older adults have available in memory about distracting material (see Hartman & Hasher, 1991).

Although evidence for the "benefits" of distractibility, as measured by greater distracter knowledge, was not found here, there clearly was evidence of a substantial cost associated with the presence of distracters. This cost was seen in the time to read simple passages. The data showed tendencies toward greater comprehension costs for older adults as well. The cost of distraction was particularly great for older adults when the extraneous information had a meaningful relation to the text at hand. Such distraction may be tied to the fact that less efficient suppression mechanisms enable more information that is meaningfully close to, but not quite part of, the comprehension path to enter activated memory (a set that includes both information in working or conscious memory and information outside of awareness; Cowan, 1988). Once activated, less efficient suppression mechanisms make that information more difficult to ignore.

It is important to note that whereas older adults are more slowed by distracters that are meaningfully related to a text than they are by distracters that share no meaning with the text, this same pattern is not seen for younger adults. Thus, similarity in meaning engages older adults in intellectual processing in a way that is not true for younger adults. Nonetheless, older adults are more slowed by any text, related or not related to the target, than are younger adults. Although the mechanisms that permit this distraction are of considerable theoretical importance, the empirical finding itself may have practical relevance for the preparation of discourse information for older adults: Unnecessary, meaningful information might best be avoided. Thus, advertisements and instructional manuals aimed at this population may need to take special note of the distractibility of older adults.

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Appendix

Example of a Text-Relevant (Experimental) Story and Questions

The Dig

The car ride river *was getting bumpy* jeep *now that* religious *George had* religious *left the main* digging tools *road to use the* religious *dirt road. He* digging tools river *was out of* jeep *school, not having* digging tools *to study* digging tools river *during the summer* jeep religious *break. He was* jeep river *glad to* digging tools *get out of* jeep *the stuffy* religious *offices* river *of* religious *the archaeology* religious *department* river jeep *and get out into* digging tools *the field. He* river *always liked* religious *going* digging tools *on archaeology* religious jeep *digs. He read that* digging tools *this dig was trying* river *to uncover* digging tools *some artifacts* religious *at a* digging tools *suspected* jeep digging tools *Indian burial site. The* digging tools jeep *site was located* river *near a* jeep *small lake in* religious *the back* digging tools *country. George* jeep river *felt the* jeep *excitement* river *building up* religious *inside himself. He* religious *heard the* digging tools *joyous* jeep *jingle of* river *his digging* jeep *equipment* river *as he hit* religious *the various bumps* river *and hills* religious *in the road. He* jeep *smiled eagerly* river digging tools *with anticipation.*

1. The artifacts were at an Indian ??? site.
hunting, burial, ceremonial,
agricultural, living, religious

2. The site was near a ???
mountain, woods, field,
pasture, river, lake

3. What was jingling?
coins, artifacts, the engine,
digging equipment, digging tools, sports equipment

4. What was George riding in?
a car, a jeep, a train,
a bus, a motorcycle, a tractor

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Call for Nominations for *JEP: Human Perception and Performance*

The Publications and Communications (P&C) Board has opened nominations for the editorship of the *Journal of Experimental Psychology: Human Perception and Performance* for a 6-year term starting January 1994. James E. Cutting is the incumbent editor.

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Charles & 34th Streets
Baltimore, Maryland 21218

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