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Age-Related Differences in Cognition: The Role of Distraction Control

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The ability to ignore or control the processing of distracting information may underlie many age-related and individual differences in cognitive abilities. Using a large sample of adults aged 18 to 87 years, this article presents data examining the mediating role of distraction control in the relationship between age and higher order cognition. The reading with distraction task (Connelly, Hasher, & Zacks, 1991) has been used as a measure of the access function of distraction control. Results of this study suggest that distraction control, as measured by this paradigm, plays an important role in mediating age-related effects on measures of working memory and matrix reasoning.

Keywords: cognitive aging, working memory, distraction, inhibition

An extensive literature documents age-related declines in a variety of complex cognitive tasks such as working memory, episodic memory, speed of processing, and abstract reasoning (e.g., Park et al., 1996; Salthouse, Atkinson, & Berish, 2003; Verhaeghen & Salthouse, 1997). Several theories have been proposed to account for these age-related declines. This study is motivated by the theory proposed by Hasher, Zacks, and colleagues (Hasher, Lustig, & Zacks, 2007; Hasher & Zacks, 1988; Hasher, Zacks, & May, 1999). These researchers have argued that attention regulation ability—and specifically the ability to down-regulate or inhibit the processing of distracting information—is a primary determinant of age-related differences in complex cognition.

One specific use of inhibition is to suppress the processing of distracting information when it first occurs. This has been termed the “access function” of attention regulation (Hasher et al., 1999, 2007). Hasher and Zacks (1988) proposed that the access function becomes less efficient with advanced age, allowing more irrelevant information to be processed along with task-relevant information, thus leading to performance declines on complex cognitive tasks. Two indices of complex cognition were used in this study: working memory and matrix reasoning.

Working memory performance has been shown to rely heavily on the frontal lobes, and especially the prefrontal cortex (see Kane & Engle, 2002, for a review). Furthermore, the frontal lobes have been shown to atrophy with increasing age (e.g., Raz et al., 2005). Although working memory capacity has been proposed as a potential mediator of age-related cognitive declines (e.g., Craik, Morris, & Gick, 1990; Hertzog, Dixon, Hultsch, & MacDonald, 2003), Hasher and Zacks (1988) have proposed that this relationship is mediated not by capacity per se, but by a more fundamental factor—the ability to control distraction. In particular, they proposed that a decrease in the access function described above could lead to an apparent decrease in working memory capacity as irrelevant information unnecessarily occupies working memory (see Lustig, May, & Hasher, 2001). In other words, irrelevant information may prevent or reduce the processing of relevant information. Matrix reasoning, as measured by tests such as Raven’s Progressive Matrices, is typically used to assess fluid intelligence and has also been shown to involve the frontal lobes (e.g., Gray, Chabris, & Braver, 2003; Kane & Engle, 2002) and to correlate negatively with age (e.g., Verhaeghen & Salthouse, 1997). It is possible that age-related differences in this task could be due, at least in part, to efficiency of the access function. For example, in a matrix reasoning task such as Raven’s Progressive Matrices, older adults may perform more poorly because of a reduced ability to ignore distraction in the form of alternative answers.

Tasks used to measure the access function of control, such as flanker tasks and local global tasks, typically assess distraction control abilities by comparing performance in baseline and interference conditions. The reading with distraction task (Connelly et al., 1991) was chosen for this study because of its ease of administration, as it can be administered using paper and pencil materials and a stop watch if computers are unavailable. In the interference condition of this task, participants must ignore irrelevant words and phrases in order to correctly read the target text of a paragraph. Tasks of this type that involve resolving conflict between competing responses have also been shown to involve frontal regions and, in particular, a region of left lateral prefrontal cortex in Broadmann’s area (Jonides, Marshuetz, Smith, Reuter-Lorenz, & Ko-

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eppe, 2000). Consequently, it is possible that age-related changes in the frontal cortex could affect participants' ability to resolve conflict between competing responses and successfully ignore irrelevant distracters. Behaviorally, this prediction has been upheld with the reading with distraction task.

In the first study comparing younger and older adults on this task, Connelly et al. (1991) found that older adults show marked susceptibility to distraction in comparison with younger adults, as measured by increased reading times and errors on comprehension tests. After the Connelly report, several groups of researchers studying age differences adopted the reading with distraction task, with nearly all replicating the basic finding of increased susceptibility to distraction in older adults (Duchek, Balota, & Thessing, 1998; Dywan & Murphy, 1996; Earles et al., 1997; Kim, Hasher, & Zacks, 2007; Salthouse et al., 2003). Additionally, increased susceptibility to distraction in this task has been shown by other groups who may have distraction control deficits, including Alzheimer's disease patients in relation to age-matched controls (Duchek et al., 1998) and individuals with high rather than low math anxiety (Hopko, Ashcraft, Gute, Ruggiero, & Lewis, 1998).

Both Earles et al. (1997) and Salthouse et al. (2003) reported high reliabilities for reading times in both baseline and interference conditions when using paragraph length materials. Other researchers have used single sentences rather than paragraphs as reading materials (Kemper & McDowd, 2006; Phillips & Lesperance, 2003). However, these researchers did not consistently demonstrate significant age differences in reading times using shortened reading materials. Consequently, our study uses the paragraph format. One possible explanation for the discrepancy between the two formats is that susceptibility to distracters during reading occurs when individuals are required to integrate and understand material over an extended length of text rather than over one sentence.

The goal of this study was to clarify the role of the access function of distraction control in the relationship between age and higher-order cognition by conducting a path analysis that included these variables. If reading with distraction measures the ability to control the processing of irrelevant information, and if this ability is critical for higher-order cognition as proposed by Hasher and Zacks' theory of distraction control (Hasher & Zacks, 1988; Hasher et al., 1999, 2007), then it follows that a measure of susceptibility to distraction from this paradigm should play an important role in mediating age-related variance in working memory and matrix reasoning.

Method

Participants

Data reported here were a part of a larger study that examined additional issues involved in distraction control and its relationship with working memory.[1] All participants came to the laboratory for two sessions, each of which lasted approximately two hours. The tasks reported here were administered at the same point during each session for each participant. The visual acuity test and demographics questionnaire were administered before the experimental tasks during the first session. Out of nine experimental tasks administered during the first session, sentence span was administered sixth, operation span eighth, and the reading with distraction task ninth. Out of nine experimental tasks administered during the second session, Raven's was administered eighth and rotation span ninth. The Shipley Vocabulary Test (Zachary, 1986) was administered after the experimental tasks during the second session. The sample was recruited from subject pools maintained by the authors, newspaper advertisements, and students enrolled in psychology classes. Psychology students received partial course credit, and community members were paid $10 an hour.

A total of 229 participants (67% female) were included in the present study, ranging in age from 18 to 87 ($M = 51.2$, $SD = 20.5$).[2] The correlation of age with scores on the Shipley vocabulary test was .39, $p < .01$. This correlation between age and vocabulary is similar to what has been reported in other studies (e.g., Park et al., 1996; Verhaeghen, 2003; Verhaeghen & Salthouse, 1997). The mean level of education obtained by participants was 16.1 year ($SD = 3.2$; age $r = .11$, *ns*). At 14.1 years ($SD = 1.5$), the youngest age band (ages 18–27) had a slightly lower level of education than did the oldest age band (ages 80–87), whose average years of education was 16.6 ($SD = 4.8$). This difference can be attributed to the high proportion of younger adults who were still in the process of completing college. Participants provided a health rating based on a scale of 1 to 5, with 5 indicating excellent health ($M = 3.2$, $SD = .61$; age $r = .02$, *ns*). Health ratings were similar across the age bands. Additionally, participants completed a test of visual acuity to ensure that they could read the size of the texts that would be presented on screen during the tasks; no participants were excluded for poor visual acuity.

Materials and Procedure

Shipley Vocabulary

In this vocabulary test (Zachary, 1986), participants were given 40 target words and asked to select the closest synonym from a group of four additional words.

Reading With Distraction

The stimuli were identical to those used by Connelly et al. (1991).[3] They consisted of eight short narrative passages, four in an interference (high distraction) condition and four in a baseline (low distraction) condition, each approximately 125 words in length. In the interference passages, four words or short phrases that were semantically related to each story's topic were repeated approximately 15 times each. We chose related distracters for the interference condition because they show the largest interference effects (Connelly et al., 1991, Experiment 2) and are the most commonly used distracters (Dywan & Murphy, 1996; Earles et al.,

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[1] For more information about the larger study, contact Rose T. Zacks or Lynn Hasher.

[2] Data from five participants (ages 39, 41, 78, 84, and 84) were excluded from the analyses either because they did not complete both sessions of the experiment or because they did not seem to understand the instructions for several of the tasks. Thus the total number of participants included in the analyses was 224.

[3] For questions about obtaining reading with distraction task materials, please contact Lynn Hasher or Rose T. Zacks.

1997; Salthouse et al., 2003). These distracters were randomly interspersed throughout each passage, appearing every two to three words, for an approximate total of 60 distracters per passage. In the baseline passages, the distracting words or phrases from the interference condition were replaced by strings of Xs of equivalent length in the same locations within the text. The strings of Xs were used in the baseline passages in order to equate paragraph length between conditions.

In all conditions, target text appeared in an italicized serif font (CG Times). In the interference condition, distracter words or phrases appeared in a regular (nonitalicized) sans serif font (Abadi MT Condensed Light). In the baseline condition, strings of *X*s appeared in an upright serif font (CG Times). The visual angle for the width of passages on screen was approximately 28 degrees. The visual angle for the height of passages on screen was approximately 23 degrees. The visual angle for the height of one line of text was approximately 0.76 degree. Participants were told to read out loud only the italicized text of each passage while ignoring the distracters appearing in upright font. Each passage was followed by a set of four 6-option multiple-choice questions, in which one answer was correct (the target) and another answer corresponded to a distracting word or phrase in the interference condition (the foil). The passages were presented in four blocks with an ABBA format in which A blocks consisted of two baseline passages and B blocks consisted of two interference passages.

Working Memory Span

Three computerized tasks—sentence span, operation span, and rotation span—were used to assess working memory capacity. During each of the working memory tasks, participants were asked to remember sets of memory items while engaged in a concurrent processing task. At the beginning of each task, each participant completed a single practice trial with a set size of two. Each participant then completed 12 test trials, consisting of 3 trials of each set size (3, 4, 5, and 6). Test trials were presented in the same pseudorandom order for each participant. A trial consisted of an alternating sequence of a processing task and memory item, with set size determined by the number of such sequences in a trial. Scoring on each working memory task was obtained by summing the number of memory items per trial that were recalled correctly. A memory item was considered correct if it was recalled from the target set, it was in the relative correct order for that set, and if the process judgment (i.e., sentence comprehension, math problem verification, or rotated letter problem) associated with that memory item was also correct. For each working memory task, scores could range from 0 to 42.

Sentence span (adapted from Daneman & Carpenter, 1980). Participants were required to make judgments about sentences while remembering a set of words. At the beginning of a trial, a participant would see a sentence and a word in a format similar to "Andy crossed the yellow heaven to get to the store. Candy." The participant read the sentence out loud and judged whether it made sense or not. The participant then read the word that followed the sentence out loud. As soon as the participant read the word, the experimenter pressed a key to bring the next sentence–word pair to the screen. This sequence was repeated until a recall prompt ended the trial. Participants recorded their recall by writing down the words they could remember in the order in which they appeared.

Operation span (adapted from Turner & Engle, 1989). Participants were required to solve elementary math problems while remembering a set of words. At the beginning of a trial, a participant would see a math problem and a word presented in a format similar to "Is (6/3) + 7 = 10 ? paper." Participants responded yes or no to the math problem and then said the subsequent word out loud. As soon as the participant read the word, the experimenter pressed a key to bring the next problem–word pair to the screen. This sequence was repeated until a recall prompt ended the trial. Participants recorded their recall by writing down the words they could remember in the order in which they appeared.

Rotation span (adapted from Shah & Miyake, 1996). Participants were required to make judgments about rotated letters while remembering a set of arrows. At the beginning of a trial, a letter appeared onscreen, rotated 0, 45, 90, 135, 180, 225, 270, or 315 degrees. Participants were asked to mentally rotate the letter until it was upright and then say "Yes" if the letter was normal or "No" if the letter was mirror-imaged. After this judgment was made out loud, the experimenter pressed a key that presented an arrow for 1000 ms. The arrows appeared at 0, 45, 90, 135, 180, 225, 270, or 315 degrees. The arrow then disappeared and the next rotated letter appeared on screen. This sequence was repeated until a recall prompt ended the trial. Participants recorded their recall by drawing in arrow locations on a response sheet in the order in which they appeared.

Raven's Advanced Progressive Matrices

In this task, participants were required to choose from eight solution options the pattern that best completed the missing cell of a 3 × 3 matrix. After completing three practice problems, participants completed the 18 odd-numbered items from Raven's Advanced Progressive Matrices (Raven, 1965). There was a 10-min time limit. Scores on this task were calculated as the number correctly completed within the time limit. Administration was by paper and pencil.

Results

The reading with distraction data were trimmed to remove outliers within subject and condition by replacing extreme values with the value corresponding to 3.5 standard deviations from the means of the baseline trials, interference trials, and difference scores between the two types of trials. Trimming affected less than 1% of the values in the data set. Thirteen missing values were replaced with means from the appropriate age groups.

Reliability Analyses of Reading With Distraction

Reliabilities for the reading time and comprehension variables were estimated by computing a coefficient alpha on the basis of the four passages within each condition for each age group. Comprehension variables had unacceptably low reliabilities (average coefficient alpha across the age groups for the baseline condition was .42 and for the interference condition was .41), and thus we do not consider these variables any further. Coefficient alphas for reading time across the age groups ranged from .77 to .96 (average = .91) in the baseline condition and from .91 to .97 (average = .95) in the interference condition. Reliability estimates for the reading time variables are presented in Table 1. Internal consistency was also estimated on the basis of four difference scores. Difference scores were computed by splitting the eight passages into four pairs (i.e., the first baseline passage and first interference passage, the second baseline passage and second interference passage, etc.) and then calculating the difference in reading time between passages in each pair. The reliability of the difference scores across the age groups ranged from .68 to .92 (average = .85). Reliabilities for all reading time variables were in the acceptable to excellent range.

We also investigated the reliability of a hypothetically shortened version of this task by submitting only the first four passages administered to reliability analyses (two baseline passages and two interference passages). The average coefficient alpha across the age groups and conditions ranged from .75 to .91. It appears that the reading with distraction task could be shortened from eight passages to four to reduce administration time (from 25 min to 15) and still remain reliable.

Descriptive Statistics and Age Relations

Descriptive statistics for reading time variables from the reading with distraction task are presented by 10-year age bands in Table 1. Average reading time tended to increase with age. Difference scores comparing reading time in the interference condition to baseline performance increased as a function of age ($r = .37$, $p < .01$). Reading time difference scores are often used as an outcome variable and are interpreted to indicate the degree to which the interference condition slowed performance above and beyond the baseline condition, with higher difference scores indicating greater susceptibility to distraction. Positive difference scores across all ages indicated that reading times were longer in the interference condition than in the baseline condition. Furthermore, the difference scores increased with age. To illustrate this trend in reading time, mean reading time difference scores for each age group were converted into standard deviation units of the youngest age group, ages 18–27 (see Figure 1).

Polynomial regression was performed to test for both linear and quadratic age-related effects on the reading time variables. For each reading time variable, two steps were involved. In the first step, the reading time variable was regressed onto age, and in the second step, an age-squared term (i.e., age^2) was added to the equation. A significant R^2 value in the first step would indicate a significant linear age trend, and a significant increment in R^2 for the second step would indicate a significant quadratic age trend. Results are displayed in Table 2. There was a significant quadratic trend for the high distraction reading time variable. However, the quadratic term accounted for only an additional 2% of the variance, whereas the linear term accounted for 25% of the variance in high distraction reading time. Thus, in the path analyses reported later, we modeled only linear age relations.

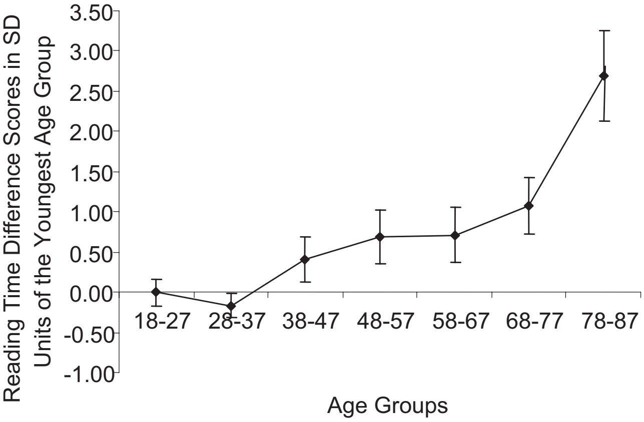

Figure 1. Converted reading time difference scores across the age groups.

Relations of Reading With Distraction to Higher-Level Cognition

As shown in Table 3, the correlation between age and the working memory composite was −.40 ($p < .01$), and the correlation between age and matrix reasoning was −.60 ($p < .01$). As was expected, young adults tended to outperform older adults on these indices of higher-level cognition. Next, the goal was to

Table 1
Reading Time Data by Age Band in the Reading With Distraction Task

		Low distraction		High distraction		H–L distraction	
Age group (yrs.)	*N*	RT	Rel.	RT	Rel.	RT	Rel.
18–27	37	51.9 (7.1)	.77	70.6 (11.5)	.91	18.6 (9.7)	.79
28–37	32	56.9 (12.6)	.94	73.9 (17.2)	.96	17.0 (8.0)	.68
38–47	30	60.6 (12.7)	.96	83.2 (25.4)	.97	22.5 (14.7)	.89
48–57	34	62.8 (11.6)	.93	88.1 (25.6)	.95	25.2 (18.7)	.90
58–67	33	64.9 (9.2)	.93	91.0 (25.9)	.95	25.5 (18.6)	.91
68–77	31	68.1 (12.5)	.94	97.7 (28.2)	.95	29.0 (19.1)	.87
78–87	27	78.6 (14.6)	.93	123.4 (38.6)	.96	44.7 (28.8)	.92
Overall	224	62.8 (13.8)	.95	88.5 (29.5)	.97	25.5 (19.1)	.90

Note. H–L distraction = high minus low distraction difference score. RT = mean reading time (standard deviation) in seconds. Rel. = estimated reliability (coefficient alpha).

Table 2
Results of Regression Analyses Testing for Linear and Quadratic Age Effects

	Step 1 Age		Step 2 Age^2	
Reading time	β	ΔR^2	β	ΔR^2
Low distraction	.55	.31*	.33	.00
High distraction	.50	.25*	.71	.02**

* $p < .01$. ** $p < .05$.

determine whether susceptibility to distraction, as measured by the reading with distraction paradigm, would play a role in mediating age-related variance in working memory and matrix reasoning. Thus, we conducted path analyses modeling this mediating relationship.

Path Analyses

Although the difference scores displayed in Figure 1 are useful for characterizing the effect of the distraction manipulation across the age range, a well-documented problem in the psychometric literature is that difference scores are typically correlated with baseline scores (see Cohen, Cohen, West, & Aiken, 2003; Faust, Balota, Spieler, & Ferraro, 1999). In this way, difference scores are "contaminated" by baseline performance. To address this issue, we included both low distraction and high distraction variables in the model, thereby statistically controlling for one variable in estimating effects of the other on working memory and matrix reasoning. The measure of working memory was the average of the three working memory tasks, and the measure of matrix reasoning was the number of correct responses in Raven's Progressive Matrices.

Results are displayed in Figure 2. Three points are noteworthy. First, there were significant positive correlations ($ps < .01$) of age with low-distraction (.55) and high- distraction (.50) reading time, indicating that reading time tended to be longer for older adults than for younger adults in both conditions, as was expected (see also Table 3). Second, age-related effects on both working memory and matrix reasoning were at least partially mediated by reading time. More specifically, correlations of age with working memory and matrix reasoning were −.40 and −.60, respectively, but the direct effects of age were −.19 ($p < .01$) for working memory and −.44 ($p < .01$) for matrix reasoning in the model displayed in Figure 2. Third, only reading time from the high-distraction condition significantly predicted working memory and matrix reasoning. That is, high-distraction reading time had a significant negative effect on working memory (−.53, $p < .01$) and matrix reasoning (−.33, $p < .01$), whereas low-distraction reading times did not (.10 and .00, both *ns*). Thus, it can be concluded that interference control, as reflected in the high-distraction reading time, played an important role in mediating age-related effects on both cognitive constructs.[4]

Table 3
Correlations Among Age, Reading With Distraction, and Higher-Order Cognition Variables

Variable	1	2	3	4	5	6
1. Age	—					
2. Low-distraction RT	.55*	—				
3. High-distraction RT	.50*	.82*	—			
4. H–L distraction RT	.37*	.53*	.92*	—		
5. WM composite	−.40*	−.43*	−.54*	−.51*	—	
6. Raven's	−.60*	−.51*	−.61*	−.47*	.55*	—

Note. RT = reading time; WM composite = working memory composite; Raven's = number correct on Raven's Advanced Progressive Matrices.
* $p < .01$.

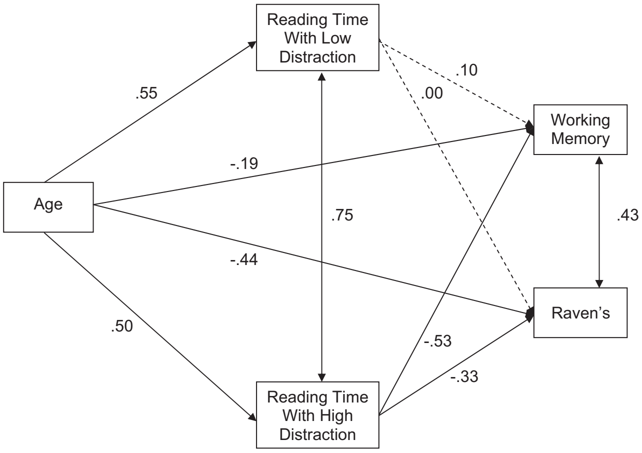

Figure 2. Path analysis with age and reading time variables predicting working memory and matrix reasoning. Values adjacent to single-headed paths are standardized regression coefficients (values for the paths leading from age to the reading time variables are equivalent to zero-order correlations of age with the variables, while values for the paths leading from the reading time variables to working memory and matrix reasoning are interpretable as semipartial correlations and thus reflect unique effects of the reading time variables; see Kline, 2003). Values adjacent to the double-headed paths are correlations.

We performed a final set of path analyses to test for invariance of effects of the low and high distraction variables on working memory and matrix reasoning across the age range. For this analysis, we created three age groups, with an approximately equal number of participants in each group: young (n = 75, 18–40 years), middle-aged (n = 74, 41–62 years), and older (n = 75, 63–87 years). For each age group, high-distraction reading time had statistically significant effects (all $ps < .05$ unless otherwise

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[4] A reviewer questioned whether the results were mostly accounted for by the oldest adults in the study, given the sharp increase in the index of susceptibility to distraction plotted in Figure 1. To answer this question, we excluded participants over the age of 76 years, and reran the model in Figure 2 (n = 197). The pattern of results was very similar to that shown in Figure 1. Paths from age to low-distraction and high-distraction reading time were .45 and .39 ($ps < .01$), respectively. Paths from low-distraction reading time to working memory and matrix reasoning were .12 and −.01 (*ns*), respectively, whereas paths from high-distraction reading time to working memory and matrix reasoning were −.52 and −.33 ($ps < .01$). Paths from age to working memory and matrix reasoning were −.18 and −.40 ($ps < .05$), respectively.

noted) on both working memory and matrix reasoning, respectively: young = −.59 and −.54; middle-aged = −.54 and −.32 (p = .053); and older = −.60 and −.41. However, low-distraction reading time did not: young = .28 and .18; middle-aged = .01 and −.11; and older = .21 and .12. Thus the interference condition influenced working memory and reasoning in each of the three age groups.

Discussion

Previous research has shown reliable age-related declines in higher-order cognition (Park et al., 1996; Salthouse et al., 2003; Verhaeghen & Salthouse, 1997). There is also evidence that age-related changes in cognition are associated with frontal lobe functioning (Dempster, 1992; Stuss, Craik, Sayer, Franchi, & Alexander, 1996). Abnormal aging, namely Alzheimer's disease, has also been associated with working memory, distraction control, and frontal lobe dysfunction (Belleville, Chertkow, & Gauthier, 2007; Borgo et al., 2003). The current study examined the relationship between age and higher-order cognition from Hasher and Zacks' (1988) theory of distraction control. This theory postulates that distraction control, or the ability to inhibit irrelevant information, plays an important role in mediating the relationship between age and higher-order cognition.

In this study, the reading with distraction paradigm was used as an indicator of distraction control. Working memory and matrix reasoning were the indicators of higher-order cognition. Previous research demonstrated that the reading with distraction paradigm has shown age-related differences in the impact of distraction on reading time (Connelly et al., 1991; Duchek et al., 1998; Dywan & Murphy, 1996; Earles et al., 1997; Kim et al., 2007; Salthouse et al., 2003). Consistent with Hasher and Zacks' theory, there is evidence from this study that susceptibility to distraction, as measured by the reading with distraction paradigm, plays a role in mediating the effect of adult age on working memory. In particular, while the low-distraction and high-distraction variables had similar correlations with age, only the latter were a statistically significant predictor of working memory and matrix reasoning. (This was true in the total sample and in young, middle-aged, and older adult subgroups.) This finding is important because a rich literature suggests that working memory—in younger and older adults—underlies performance on a range of tasks, including problem solving, decision making, language comprehension, abstract reasoning, and complex learning (e.g., see Hambrick & Engle, 2003, for a review). However, it is possible, as Hasher and Zacks (1988; Hasher et al., 1999, 2007) have speculated, that the ability to regulate distraction is a critical factor underlying age differences in working memory and other cognitive abilities (Lustig et al., 2001). It should be noted that some of the tasks were administered late in the testing sessions, and thus it is possible that our aging results are due to differential fatigue in older participants. However, our results are very much in line with results from studies that used much smaller test batteries and in which fatigue would not be expected to be a factor (e.g., Connelly et al., 1991).

Although the psychometric properties of the reading with distraction task were not the main focus of this article, we recommend this paradigm as a reliable and easily administered task that can be used by many researchers to assess what Hasher and Zacks term the access function of distraction control in developmental, abnormal, and individual differences studies. There was evidence for internal consistency in reading times across all age groups and conditions in this task; however, measures of comprehension accuracy were not reliable. This pattern of results has been reported elsewhere (Salthouse et al., 2003). We also found internal consistency in reading times of a hypothetically shortened version of the reading with distraction task. Future studies could actually administer a shortened version of this task and cross-validate it with other measures of distraction control. Furthermore, research is needed to establish the construct validity of this task with other measures of distraction control within Hasher and Zacks' theoretical framework.

Overall, this study provides evidence to suggest that distraction control plays an important role in mediating the relationship between age and higher-order cognition. Studies such as this one inform researchers of the possible connections between the physiological and behavioral underpinnings of cognitive aging. The importance of distraction control, albeit under different terminology, has also come to play a major role in theories of development, individual differences, and in neurocognitive functioning (e.g., Dempster, 1991; Gernsbacher & Robertson, 1995; see also Bunting, 2006; Engle & Kane, 2004; Spieler, Balota, & Faust, 1996). Additional psychometric and experimental research is needed to establish and expand our knowledge of the role of distraction control in individual and developmental differences in cognition.

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