Adult Age, Information Processing, and Partial Report Performance

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ABSTRACT. Previous investigations using the partial report technique for examining adult age differences in iconic memory have suggested that older adults are less able to extract information stored in the icon than are young adults. The present study examined the hypothesis that poorer partial report performance on the part of older adults involves age-related differences in the speed of visual and auditory information processing. Elderly (M = 67 years) and young (M = 23.5 years) adults were contrasted on partial report, whole report, backward masking, and choice reaction time tasks. Results indicated that the older age group exhibited a smaller partial report advantage than did their younger counterparts. This age difference was found to be related in part to increases with age in the time required to encode and identify visual stimuli but was not related to the time required to translate auditory cues into recall instructions. In other words, the slowdown in visual information processing speed that accompanies increased age contributes to age differences in performance on tasks involving iconic memory.

PERCEPTION OF A VISUAL STIMULUS typically outlasts the stimulus that produced it (Sperling, 1960). This very brief storage of information, which may be termed iconic memory, represents the initial stage of memory and serves to maintain an exact representation of sensory input. One procedure that has been used to examine the nature of iconic memory is the partial

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report paradigm (Sperling, 1960), which requires that observers report only a subset of items from a larger display that has been briefly presented. Through the use of this technique, Sperling demonstrated that more information is available to an observer than is apparent when a whole report is required (i.e., when recall of the entire display, rather than just a subset, is requested).

Several investigators have used the partial report technique to examine adult age differences in iconic memory (e.g., Salthouse, 1976; Walsh & Thompson, cited in Walsh & Prasse, 1980). These studies have typically found that older adults are less able to use information stored in iconic memory than are young adults. Although the underlying basis for the lowered performance of older adults is not readily apparent, Salthouse and Walsh and Prasse have suggested that age differences in attentional strategies may be responsible. Another contributing factor may be related to Crowder’s (1976) observation that, because Sperling’s (1960) partial report technique involves the interpretation of an auditory cue, a decision process that is not absolutely instantaneous, the icon may decay even before an observer has identified the appropriate row of letters to be recalled. This may put older adults at a disadvantage, as the old typically require more time than do the young to carry out the decision processes necessary to interpret stimuli (Birren, Woods, & Williams, 1980). Crowder also suggested that, because readout from the appropriate row, once selected, requires a finite amount of time, “still more decay of the icon” may occur prior to completion of the task. Because older adults require more time than do young adults to encode and identify visually presented stimuli (Walsh & Prasse), this factor may also serve to impair partial report performance of the old.

The influence of these latter two factors was investigated in the present study by examining the relationship between adult age and partial report performance in light of potential age differences in the speed of visual and auditory information processing. Both age groups were expected to report a larger percentage of briefly presented letters under partial report than whole report conditions, although this partial report advantage was expected to be smaller for the old than for the young (Salthouse, 1976). Furthermore, age differences in the time required to process visual information (as indexed by a backward masking task) and the time required to decode tone cues (as indexed by a choice reaction time task) were expected to account for significant portions of the variance in partial report performance.

Method

Subjects

Two age groups participated in the present investigation: young adults \( n = 24; M = 23.5 \) years; range = 20 to 29 years) and elderly adults \( n = 25; M \)
= 67 years; range = 60 to 74 years). There were 11 men and 13 women in the young adult group and 14 men and 11 women in the older adult group. All participants were community residents and provided their own transportation to the laboratory. Age groups were comparable in terms of raw score performance on the Information subtest of the Wechsler Adult Intelligence Scale-Revised (WAIS-R), $F(1, 48) = 1.30, p > .05$, although there was a significant age group difference in years of education completed, $F(1, 48) = 9.45, p < .01$. Average Information subtest performance of the old was 23.5, as compared to 24.4 for the young; average years of education completed were 14.1 and 15.7 for old and young adults, respectively.

**Procedure**

Data collection involved partial report, whole report, choice reaction time, and backward masking procedures administered in a counterbalanced order. The partial report trials involved the presentation (for 50 ms) of a $2 \times 4$ letter array consisting of randomly selected consonants of the alphabet. All letters were printed in black 7-mm Futura Medium type on white cards, and each array subtended a visual angle of $1.41^\circ$ vertical by $3.27^\circ$ horizontal. On each trial, letter arrays were presented to the right eye via a Gerbrands three-channel tachistoscope and were viewed through a 3.5-mm cornea-adjacent artificial pupil to minimize the potential contribution of age differences in pupil diameter. The luminance level of each array was set at 2.00 fL, as measured by a Spectra Spotmeter. Ambient room illumination was provided by a 15 W fluorescent lamp mounted out of the observer's line of sight.

On each trial, the offset of a letter array was followed immediately by one of two tones presented in a random order: a high (1,000 Hz) tone instructed the observer to recall the top row of the array whereas a low (500 Hz) tone signalled recall of the bottom row. A total of 50 trials was presented, each involving different letter arrays. The percentage of letters correctly reported, averaged across all trials, represented partial report performance.

Whole report trials were carried out in a fashion similar to those of partial report. On each trial, different $2 \times 4$ letter arrays were presented tachistoscopically for 50 ms and were followed by one of two tones (presented in a random order). Unlike the partial report trials, however, the tones that followed each letter array merely instructed observers to recall as many letters presented as possible. A total of 50 trials was presented; whole report performance was defined as the percentage of letters, averaged across all trials, that were correctly reported.

Choice reaction time trials were conducted in the following manner. On each trial, observers were presented with a three-letter array (arranged vertically) and one of three randomly presented tones. A high (1,000 Hz), medium (750 Hz), or low (500 Hz) tone indicated that the top, middle, or
bottom letter, respectively, must be read aloud. Participants were instructed to respond as rapidly yet as accurately as possible. On each trial, a participant's vocal response triggered a Gerbrands Model 1341 Voice Operated Relay, which in turn stopped a digital millisecond clock. Response latencies (in ms) were recorded by the experimenter; median response latencies were subsequently computed, based on a total of 50 trials.

Finally, backward masking trials involved the presentation of a 50-ms-duration target stimulus (TS) consisting of a 1 × 4 letter array (subtending a visual angle of .51° by 3.27°). Following a variable-duration dark interstimulus interval (ISI), a masking stimulus (MS) was presented for 50 ms. The MS consisted of randomly arranged line segments similar to those making up the TS and subtended a visual angle of 4° by 4°. All stimuli were presented tachistoscopically to the right eye at a luminance level of 2 fL. On each trial, the critical interstimulus interval (ISI°) between TS and MS necessary to escape visual masking was determined using a method of ascending limits. The ISI was initially set at 0 ms and was increased in 2-ms steps until two consecutive letter arrays were correctly identified. The ISI° value was taken as the shortest ISI at which this criterion was met.

Results and Discussion

The partial and whole report data were analyzed via a 2 × 2 (Age Group × Report Type) repeated measures analysis of covariance. Backward masking and choice reaction time performance data were employed as covariates. The between-subjects factor of sex was dropped from the analysis because preliminary analyses indicated no main effect or interactions involving this factor. The analysis indicated significant main effects of age, $F(1, 45) = 22.70, p < .001, \omega^2 = .199$, which reflected a lower level of report on the part of older adults, and report type, $F(1, 47) = 59.26, p > .001 \omega^2 = .118$, which was associated with a higher level of report for both age groups under partial report conditions. A post-hoc examination of the means contributing to these main effects, via the Newman-Keuls procedure, indicated that both elderly and young adults exhibited a partial report advantage (all $p$'s < .05). More important, however, the older adults benefited less than did the young adults from partial report cueing, as was indicated by the finding of a significant Age × Report Type interaction, $F(1, 47) = 17.12, p < .001, \omega^2 = .033$. Table 1 presents mean whole report and partial report scores for young and old adults.

With respect to the two measures employed as covariates, significant amounts of variance were accounted for by age differences in backward masking susceptibility, $F(1, 45) = 4.90, p < .05, \omega^2 = .036$, but not by age differences in choice reaction time performance, $F(1, 45) = 1.71, p > .05$. Older adults required an average of 84.84 ms (± 50.12) to escape the per-
TABLE 1
Mean Whole Report and Partial Report Scores (± One Standard Deviation) for Young and Elderly Adults

<table>
<thead>
<tr>
<th>Age</th>
<th>Whole report %</th>
<th>Partial report %</th>
</tr>
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<tbody>
<tr>
<td>67.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>44.25 (± 11.6)</td>
<td>49.09 (± 14.3)</td>
</tr>
<tr>
<td>23.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>62.33 (± 9.7)</td>
<td>78.42 (± 10.3)</td>
</tr>
</tbody>
</table>

<sup>a</sup>n = 25. <sup>b</sup>n = 24.

ceptual interference of a visual mask, whereas the young required 45.58 ms (± 43.61). This difference between age groups was significant, F(1, 48) = 8.53, p < .01, \( \omega^2 = .133 \). In addition, the average choice reaction time of the old was 1,832.72 ms (± 363.69), as compared to 1,310.92 ms (± 366.46) for the young. Although this age difference was significant, F(1, 48) = 25.02, p < .001, \( \omega^2 = .329 \), it was not associated with significant amounts of variance in whole and partial report performance.

The above findings, therefore, confirm the conclusions of previous investigations (e.g., Salthouse, 1976; Walsh & Thompson, cited in Walsh & Prasse, 1980) in suggesting that the ability to use information stored in iconic memory declines with increased adult age. More important, the current findings indicate that an age-related decrease in the rate at which items can be read out from the icon prior to decay (as indexed by backward masking performance) contributes to age differences in iconic memory. The age differences in susceptibility to backward masking noted in the current study do not, however, account for the full extent of the age-related differences in partial report performance. Although additional factors influencing performance are not directly apparent from the present study, work by Salt- house (1976), as noted earlier, suggests that at least part of the remaining age differences may be associated with the use, by each age group, of different strategies to access the information stored in the icon.

REFERENCES


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