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Memory Factors in Age-Related Differences in Simple Reasoning

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Adults in their 50s were compared with adults in their late teens or 20s in the accuracy of relatively simple reasoning decisions involving varying amounts of information. Because the magnitude of the age differences in decision accuracy was independent of the amount of information relevant to the decision, it was suggested that adults in their 20s and 50s do not differ in the effectiveness of integrating information across multiple premises. However, the 2 groups differed in the accuracy of trials involving only a single relevant premise, and thus it was inferred that 1 factor contributing to reasoning differences within the age range from 20 to 60 may be a failure to encode, or retain, relevant information.

Salthouse, Mitchell, Skovronek, and Babcock (1989) recently reported a study in which a verbal reasoning task and two other tasks were administered to 120 adults between 20 and 79 years of age. Three of the major results of the study were (a) decision accuracy declined with increases in the number of premises presented prior to the reasoning question, (b) similar declines were apparent when only one of the presented premises was relevant to the decision and when two or more of them were relevant, and (c) in both types of trials the effects of the number of presented premises were more pronounced with increased age.

This pattern of results can be interpreted as suggesting that many reasoning difficulties, particularly those associated with increased age, might be related to limitations of working memory in that relevant information is apparently not available when needed. The present article extends Salthouse et al.'s (1989) investigation of the influence of memory on reasoning by reporting (a) additional analyses of portions of the earlier data, with a special focus on measures of study time and decision time, and (b) a new age-comparative study with several methodological modifications.

The reasoning task developed by Salthouse et al. (1989) involved the successive presentation of one to four premises, each describing the relation between two variables, followed by a question asking what will happen to one variable if a specified change is introduced in another variable. The task was designed such that on some of the trials both of the variables in the question were originally mentioned in the same premise, whereas in other trials the variables were mentioned in different premises, and consequently information had to be integrated across two or more separate premises to reach a decision (see Figure 1).

It was postulated that a comparison of performance in trials with one relevant premise and in trials with two or more relevant premises would allow a distinction to be made between memory factors and reasoning or integration factors, as determinants of decision accuracy and decision speed. The rationale was as follows. First, all trials in which a single premise is relevant to the decision can be assumed to involve the same decision processes because they are based on the same information (i.e., two variables described in one premise) and differ only with respect to the context in which that information is presented. As more premises are presented it may take more time to retrieve the relevant premise, and there may be a lower probability that the relevant premise can be successfully retrieved. However, as long as the premise containing the target variables is available in memory, exactly the same decision processes should be required regardless of the number of other premises presented. Any variations in decision time or decision accuracy with one-relevant trials as a function of the number of presented premises can therefore be attributed to characteristics associated with memory (i.e., time to search and retrieve or failure to retain), rather than to limitations associated with information integration or reasoning per se.

On the other hand, when the target variables in the question were originally mentioned in different premises, successful performance in the task requires that, in addition to preservation and retrieval of the information, information must be integrated across two or more premises. In these trials, declines in accuracy with an increase in the number of presented premises could therefore occur, either because the critical information is not available when needed or because the information cannot be successfully integrated across multiple premises. Similarly, an increase in decision time with additional presented premises could result either because there is more information to search or because additional time is required to reorder and integrate the information.

The relative contributions of memory factors and reasoning or integration factors to performance in the present reasoning task should therefore be distinguishable by contrasting the effects of the number of presented premises in trials with only one relevant premise, and in trials in which all premises are

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relevant. According to the argument outlined above, all of the effects with one-relevant trials can be attributed to memory factors, and thus any greater effects with all-relevant trials compared with one-relevant trials can be assumed to be due to the requirement of integrating information across premises.

Note that the preceding interpretation is independent of when, during the course of a trial, the information integration occurs. Because the critical information in one-relevant trials is presented in a single premise, whether the across-premises integration of information occurs after each successive premise or only after the presentation of the question should be irrelevant. It is nevertheless desirable to attempt to minimize variations in task strategy in studies of individual differences in performance, and consequently the immediate (after each premise) integration strategy was discouraged by presenting the premises in a random order. For example, the premises in Figure 1 are displayed in a 3–1–2 order because the variables mentioned in the first premise are the last ones in the alphabetical sequence. We assumed that cases such as this, in which neither a categorical nor an ordinal relation among the variables could be established until after the presentation of the final premise, would discourage efforts to organize or integrate the information after each successive premise.

The purpose of these studies was to extend the earlier results by both examining and further controlling the strategies used by participants in the tasks. In Study 1, we investigated patterns of premise inspection time and decision time as a means of assessing task strategy and confirming that the manipulation of number of relevant premises was salient enough to produce detectable effects on a meaningful dependent variable. Premise inspection time was controlled in Study 2 to constrain the amount of processing that could take place after each premise, and serial-position analyses were also conducted to determine when the information from single premises was no longer available.

Study 1

The data reported herein are a subset of those collected in a study described by Salthouse et al. (1989). The complete study involved 20 adults in each decade from the 20s through the 70s who each performed three distinct tasks (verbal reasoning, spatial paper folding, and computational working-memory span). Only the reasoning task was of interest in this study, and the analyses were further restricted to contrasts of adults in their 20s and 50s because accuracy in many conditions was near the chance level for older participants. Unlike the previous report, the present analyses included measures of study and decision time as well as of decision accuracy.

Method

Subjects. All participants were male students or alumni of Georgia Institute of Technology. The 20s group had a mean age of 25.1 (range = 20 to 29), a mean education level of 16.3 years, and a mean self-reported health status of 1.40 on a scale ranging from *excellent* (1) to *poor* (5). Corresponding values for the 50s group were mean age of 53.8 (range = 50 to 59), mean education level of 16.7 years, and mean self-reported health status of 1.20.

Procedure. The reasoning task, which was presented on a computer, consisted of successive premises such as "R and S do the SAME," and "Q and R do the OPPOSITE," followed by a question such as "If Q INCREASES, what will happen to S?" Each premise described the relation between two adjacent letters in the alphabetical sequence, but successive premises did not necessarily describe adjacent letters (see Figure 1 for an example). Each of two experimental blocks contained four trials of each of 10 trial types consisting of 1, 2, 3, or 4 premises, with from 1 to *n* premises relevant to the decision. In other words, there were four trial types containing four premises (with 1, 2, 3, or 4 relevant premises), three trial types containing three premises (with 1, 2, or 3 relevant premises), and so forth. Each block contained a random arrangement of two positive (INCREASE) and two negative (DECREASE) trials of each type. Feedback indicating the correct answer in the trial was displayed after each response.

A trial was initiated by pressing the ENTER key on the computer keyboard. The first premise was then displayed, and each successive premise was displayed by pressing ENTER again. The question display was accompanied by the words INCREASE on the lower left of the screen and DECREASE on the lower right of the screen, and decisions were communicated by pressing the Z key (lower left on the keyboard) for INCREASE and the slash key (lower right on the keyboard) for DECREASE. Participants were instructed to emphasize accuracy more than speed but were encouraged to respond in the minimum time consistent with maximum accuracy.

Results and Discussion

Only the data from trials in which one of the premises or all of the premises were relevant to the decision were examined for the analyses of decision time and decision accuracy. These data, which are displayed in Figure 2, were analyzed with an Age (20s or 50s) × Number of Premises (two, three, or four) × Number of Relevant Premises (one or all) analysis of variance (ANOVA). Separate ANOVAs were conducted on the decision time and decision accuracy variables, and in both cases trials with only one premise were excluded because of the inability to distinguish

G and H do the OPPOSITE

E and F do the SAME

F and G do the OPPOSITE

- -

One Relevant:

If G DECREASES, what will happen to H?

Two Relevant:

If F INCREASES, what will happen to H?

Three Relevant:

If E DECREASES, what will happen to H?

Figure 1. The premises (above dotted line) and different types of questions (below dotted line) for reasoning task. (Only one question appeared on a given trial.)

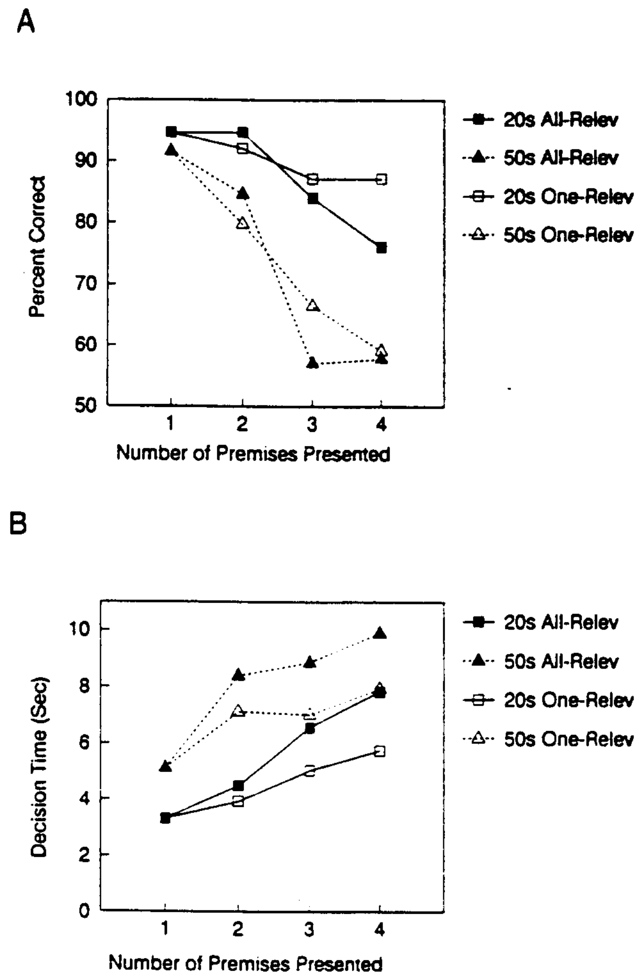

Figure 2. A: Percent correct decisions for adults in their 20s and 50s as a function of number of premises presented for trials with one relevant premise and trials in which all premises were relevant (Study 1). B: Median decision time for adults in their 20s and 50s as a function of number of premises presented for trials with one relevant premise and trials in which all premises were relevant (Study 1).

between the number of premises presented and number of relevant premises variables in this condition.

Accuracy declined in both the 20s and the 50s groups as more premises were presented, the declines were more dramatic in the 50s group than in the 20s group, and the magnitudes of those declines in both groups were similar for one-relevant trials and for all-relevant trials (Figure 2A). These patterns were confirmed in the ANOVA because there were significant ($p < .01$) effects of age, $F(1, 38) = 28.40$, $MS_e = 789.01$; number of premises, $F(2, 76) = 37.51$, $MS_e = 186.46$; and Age × Number of Premises, $F(2, 76) = 5.42$, $MS_e = 186.46$; but not for number of relevant premises, $F(1, 38) = 3.36$, $MS_e = 150.85$, $p > .05$. None of the other interactions involving age were significant (all $ps > .05$).

Results with the median decision time measure are illustrated in Figure 2B. Notice that decision time increased as more premises were presented and that the increase in decision time appears greater with all-relevant trials than with one-relevant trials for both the 20s and the 50s groups. This impression was confirmed in the statistical analyses because in addition to the significant ($p < .01$) effects of age, $F(1, 38) = 7.82$, $MS_e = 51{,}841$, and number of premises, $F(2, 76) = 8.38$, $MS_e = 8{,}352$, there was also a significant effect of number of relevant premises, $F(1, 38) = 15.62$, $MS_e = 9{,}091$. None of the interactions involving the age variable were significant (all $ps > .05$).

The results just described replicate and extend those reported by Salthouse et al. (1989). The earlier results are replicated in these subsamples because decision accuracy decreased as more premises were presented, and to a greater extent for older adults than for young adults, but accuracy did not vary as the number of premises relevant to the decision increased. It is not simply that the number-of-relevant-premises manipulation was too weak to produce measurable consequences, because significant relevance effects were evident with the decision-time variable. In this respect, the current results extend those reported previously.

The average times spent inspecting each successive premise in trials with 1, 2, 3, or 4 premises are displayed in Table 1. Separate Age × Premise Position ANOVAs were conducted on the data from trials with two or more premises. Neither the main effect of age nor the interaction of Age × Premise Position was significant in any of these analyses ($Fs < 3.9$, $p > .05$). The effect of premise position was not significant with two-premise trials, $F(1, 38) = 0.19$, $MS_e = 77{,}201$, $p > .5$, or with three-premise trials, $F(2, 76) = 2.20$, $MS_e = 1{,}874$, $p > .05$; however, it was significant with the data from four-premise trials, $F(3, 114) = 4.69$, $MS_e = 3{,}015$, $p < .01$.

These study-time data are interesting in two respects. First, they provide no indication that the two groups of adults performed the task in different ways. That is, the study-time profiles across successive premises reflect the individual's strategy for performing the task because they indicate the distribution of processing times across various phases of the trial. The ab-

Table 1
Study Times (in Seconds) for Adults in Their 20s and 50s for Successive Premises in Study 1

	Premise position			
Condition	1	2	3	4
One premise				
20s	3.22	—	—	—
50s	4.14	—	—	—
Two premises				
20s	3.89	4.33	—	—
50s	5.37	5.20	—	—
Three premises				
20s	3.99	4.48	4.43	—
50s	4.76	5.37	5.46	—
Four premises				
20s	3.90	4.92	5.50	4.94
50s	5.01	5.54	6.29	5.14

Note. Dashes indicate that no trials were presented in these conditions.

sence of significant Age × Premise Position interaction can therefore be interpreted as suggesting that there were no substantial differences between the groups in the strategies of allocating processing times across premises within the trial.

The second interesting finding was that there was a tendency for study time to increase across successive premises. It is unclear whether this result is attributable to the participants' attempting to integrate premises into a simpler organization as they were presented or to their engaging in progressively lengthier cumulative rehearsal with each successive premise. In either of these cases, there is the possibility that potentially important individual differences might have existed in the strategy used to perform the task. It was therefore considered desirable to conduct a second study in which individual variations in processing strategy might be minimized.

Study 2

Further examination revealed several limitations of Study 1, and hence we decided to attempt to replicate the major results with several procedural modifications. As noted previously, one undesirable characteristic of Study 1 was that research participants were allowed to inspect each premise as long as desired. This resulted in considerable variability in inspection times and perhaps also in the strategies used to perform the task. In particular, because the study duration for each premise was controlled by the participants, some of them may have spent more time studying each successive premise in an attempt to integrate or cumulatively rehearse the premises as they were presented, rather than simply remembering the items and carrying out the integration at the time of the question. Changing from self-paced premise durations to a fixed duration of 2.5 s was the modification introduced to attempt to minimize variation across individuals in the amount of processing devoted to each premise during its presentation.

A second weakness of Study 1 was that the 50s group was performing near the chance accuracy level when four premises were presented, even with only a single relevant premise. To avoid this problem, the maximum number of premises presented in a trial in Study 2 was three.

A third limitation of Study 1 was that the ordinal positions in which single relevant premises were presented were not preserved in the data files. It was therefore impossible to conduct serial-position analyses that might have been informative about when, during the course of a trial, the information from a single premise was no longer available. A modification of the experiment program to allow control and recording of the serial position of one-relevant premises was introduced to overcome this limitation.

Method

Subjects. Participants were 20 undergraduates at Georgia Institute of Technology and 20 community-residing adults. The students had a mean age of 19.2 years (range = 18 to 22), an average of 14.2 years of education, and a mean self-reported health of 1.75 on the 5-point scale described earlier. Corresponding values for the other group of participants were mean age of 56.0 years (range = 51 to 60), a mean education level of 14.4 years, and a mean self-reported health status of 1.45.

Procedure. The reasoning task was similar to that of Study 1, with the following modifications: (a) The inspection time for each premise was restricted to 2.5 s rather than left under the control of the participant, (b) only one to three premises were presented on any given trial, and (c) the program was modified to present the single relevant premise an equal number of times in each serial position and to record the order of premise presentation on each trial. In addition, instructions were slightly changed to emphasize the speed of the decisions as much as their accuracy. The purpose of this modification was to determine whether the decision-time results from Study 1 would be replicated when the research participants were encouraged to respond both rapidly and accurately.

Trials were presented in four blocks of 45 trials each, after a repeatable set of 5 practice trials. The 45 trials within each block were composed of 9 trials each of (a) one premise, and it was relevant; (b) two premises, one of which was relevant; (c) two premises, both relevant; (d) three premises, one of which was relevant; and (e) three premises, with all three relevant. For half the trials, the correct answer was "Increase," and for the other half it was "Decrease." Trials with each type of correct response, and with different numbers of presented and relevant premises, were randomly intermixed within each trial block.

Results and Discussion

The variables of percent correct decisions and median decision time for trials with two or three premises were analyzed in Age (20s or 50s) × Number of Premises (two or three) × Number of Relevant Premises (one or all) ANOVAS. As in Study 1, age, $F(1, 38) = 25.20$, $MS_e = 462.86$; number of premises, $F(1, 38) = 44.17$, $MS_e = 87.41$; and Age × Number of Premises, $F(1, 38) = 7.51$, $MS_e = 87.41$, were the only significant ($p < .01$) effects with the accuracy variable. However, the direction of the interaction was different from that of Study 1 because, as Figure 3A illustrates, in this study the age differences were actually somewhat smaller, rather than larger, with a greater number of premises. The low performance of the 50s group, particularly when three premises were presented, raises the possibility that the interaction in Study 2 may have simply been due to a measurement artifact, and consequently this rather minor inconsistency in the statistical outcomes should probably not be taken too seriously.

The decision-time results from Study 1 were replicated in that there was a greater increase in decision time when all premises were relevant to the decision than when only one premise was relevant (Figure 3B). Both the number of premises, $F(1, 38) = 10.74$, $MS_e = 1{,}729$, and the number of relevant premises, $F(1, 38) = 27.53$, $MS_e = 1{,}921$, effects were significant ($p < .01$), but the age effect was not, $F(1, 38) = 1.42$, $MS_e = 12{,}499$, $p > .05$. Age differences were evident in the form of a significant Age × Number of Premises × Number of Relevant Premises interaction, $F(1, 38) = 11.00$, $MS_e = 227$, $p < .01$. This result was due to the slower decision times in the 50s group compared with the 20s group in all but the three-premise, all-relevant condition (Figure 3B).

Analyses were also conducted of the accuracy in trials with only a single relevant premise as a function of the serial position of the relevant premise. The effect of age was significant ($p < .01$) in the analyses with three premises, $F(1, 38) = 13.77$, $MS_e = 318.19$, and two premises, $F(1, 38) = 13.60$, $MS_e = 461.90$. The position effect was not significant ($p > .05$) in either

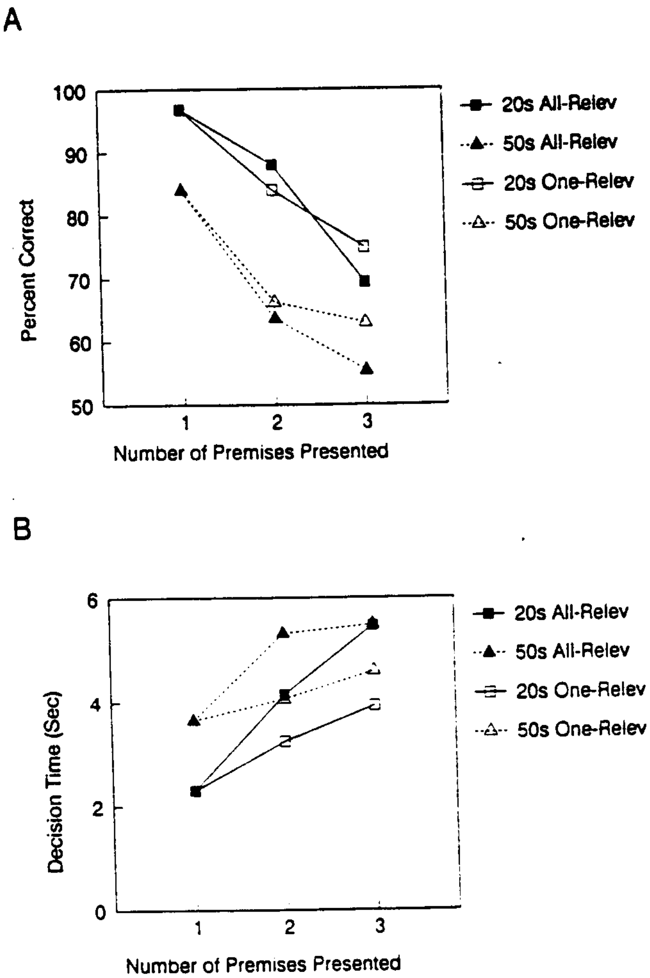

Figure 3. A: Percent correct decisions for adults in their 20s and 50s as a function of number of premises presented for trials with one relevant premise and trials in which all premises were relevant (Study 2). B: Median decision time for adults in their 20s and 50s as a function of number of premises presented for trials with one relevant premise and trials in which all premises were relevant (Study 2).

analysis: $F(2, 76) = 1.86$, $MS_e = 159.13$, for three premises: $F(1, 38) = 2.14$, $MS_e = 79.97$, for two premises. The Age × Position interaction was significant with three premises, $F(2, 76) = 3.86$, $MS_e = 159.13$, $p < .05$, but not with two premises, $F(1, 38) = 0.83$, $MS_e = 79.97$, $p > .05$.

The lack of an interaction between age and serial position with two premises is largely due to the absence of a serial-position effect in either group with only two premises. That is, the mean percent correct values for the 20s group were 84% for the first position and 88% for the second position, and those for the 50s group were 66% for the first position and 64% for the second position. The serial-position effects with three premises are illustrated in Figure 4, which shows that the two groups were nearly equivalent at early serial positions, but that the 20s group was much more accurate than the 50s group in later positions involving more recently presented premises.

The very low accuracy of the 50s group with three premises raises the possibility that the participants in this group did not exhibit a serial-position effect similar to that of the 20s group because their average accuracy was near the chance level. To examine this possibility, another analysis was conducted in which participants in each age group were divided into high- and low-ability groups on the basis of their median accuracies in three-premise, one-relevant trials. This ability distinction then served as another factor in an Age × Ability × Premise Position ANOVA. The results from this analysis were similar to those of the earlier analysis in that the effects of age, $F(1, 36) = 38.96$, $MS_e = 99.68$, $p < .01$, and Age × Premise Position, $F(2, 72) = 4.42$, $MS_e = 153.75$, $p < .05$, were significant. Especially interesting in this analysis is that the ability variable did not interact significantly with age, $F(1, 36) = 2.78$, $MS_e = 99.68$, $p > .05$, or with Age × Premise Position, $F(2, 72) = 2.61$, $MS_e = 153.75$, $p > .05$. These latter contrasts have relatively low power and thus they cannot be considered definitive, but the failure to detect significant ability interactions suggests that the patterns apparent in Figure 4 are not restricted to a particular subset of these samples of 20- and 50-year-olds.

General Discussion

The reasoning task used in these studies was designed to allow investigation of the relative contributions of memory and integrative reasoning to decision accuracy and decision time by simultaneously varying the number of presented premises and the number of premises relevant to the decision. Our assumption was that this reasoning task is often performed by encoding and retaining each successive premise, encoding the question, searching and retrieving relevant information from the stored premises, integrating the information across premises when necessary, and, finally, evaluating the information to reach a decision. At least some of the information integration may take place after the presentation of each successive premise, although the significant effect of the number of relevant premises on the decision-time variable indicates that considerable integration probably occurs after the presentation of the question. Furthermore, the question of when the integration occurs is, from the present perspective, less important than the issue of

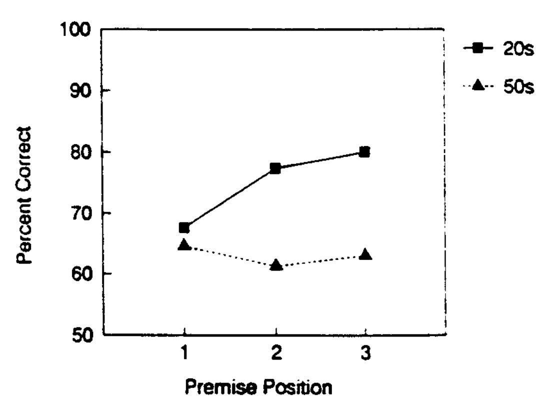

Figure 4. Percent correct decisions for adults in their 20s and 50s in three-premise, one-relevant trials as a function of the serial position of the relevant premise (Study 2).

whether across premises integration is required by virtue of the relevant information having originally been presented in separate premises.

The significant increase in decision time with an increase in the number of presented premises suggests that searching and retrieving information takes longer when there are more premises in memory. The decrease in accuracy for one-relevant trials with additional premises can be interpreted as indicating that there are limits on the amount of information that can be preserved because low accuracy in these trials seems attributable to unavailability of the information. However, the failure to find an effect of the number of relevant premises on decision accuracy suggests that no further loss of information is caused by the requirement to integrate information across premises. These integration processes do require additional time, as reflected in the significant effect of the number of relevant premises on decision time, but they apparently do not contribute to further losses of information.

The results of Studies 1 and 2 allow a number of inferences about where in the hypothesized processing sequence the observed age differences originate. First, the similar profiles of study times across successive premises in Study 1 suggest that the two groups used comparable strategies to perform the tasks, at least with respect to the amount of processing time allocated to the inspection of each premise. Furthermore, in both studies, adults in their 20s and in their 50s exhibited similar increases in decision time with more premises, implying roughly equivalent processes of search and retrieval, and with more relevant premises, implying comparable integration processes. Combined, these results suggest that the two groups did not differ markedly in the manner in which they performed the tasks.

Somewhat different effects of the number of presented premises on decision accuracy were evident in Studies 1 and 2. Although in both cases accuracy decreased as more premises were presented, the magnitude of the decrease was much more pronounced for the 50s group than for the 20s group in Study 1, whereas this pattern was not apparent in Study 2. The change from self-paced inspection times in Study 1, which averaged more than 5.2 s per premise for the 50s group, to a fixed duration of 2.5 s in Study 2 was probably a major factor responsible for this difference. That is, with the shorter inspection durations, the 50s group was less accurate than the 20s group even on trials in which only a single premise was presented (cf. Figure 3, upper panel), and their average performance was close to chance when three premises were presented. Other factors that might have contributed to the slightly different interaction patterns in Studies 1 and 2 are a difference in the average number of years of education in the two older groups (16.7 in Study 1 vs. 14.4 in Study 2) and a shift from an emphasis on accuracy in Study 1 to an equal emphasis on speed and accuracy in Study 2.

One of the most important findings in these studies is that in neither age group was there a significant effect of the number of relevant premises on decision accuracy. If reasoning is equated with the process of integrating information across multiple premises, then the results imply that neither adults in their 20s nor those in their 50s have difficulty in simple reasoning. What does appear to distinguish the two groups is the availability of relevant information when it is to be integrated. That is, the discovery of age differences in the accuracy of one-relevant trials implies a difference in information availability because when there is only a single relevant premise, variations in accuracy as more premises are presented are presumed to reflect the availability of the information in memory. The combination of sizable age-related differences in the accuracy of one-relevant trials and little or no differences in the effect of the number of premises relevant to the decision therefore suggests that aging-related processes influence the likelihood that information will be available, but not the success with which it can be integrated given that it is available.

Some indication of the reasons for the age differences in information availability can be derived from the serial-position analyses of Study 2. For example, if the two groups had been equivalent when the relevant premise was presented in the last, or most recent, serial position, but differed when it was presented in earlier serial positions, then it could have been inferred that there was a more rapid loss of information with increased age. Alternatively, if the serial-position functions of the two groups had been parallel, then one might argue that the age differences were attributable to processes independent of the serial-position phenomenon, such as those concerned with the decision or the response. The pattern actually observed, as illustrated in Figure 4, was that adults in the 20s group exhibited a classical serial-position effect with an advantage for the most recently presented premise, but adults in their 50s showed no effect of serial position. The discovery of similar results in the statistical analyses when the participants in each group were divided into high- and low-performing subgroups reduced concerns that the failure to find a serial-position effect in the 50s group was attributable to near-chance levels of performance.

The absence of an advantage for the most recently presented premises in the 50s group suggests that in many trials the relevant premise information may never have been adequately encoded. The age difference in accuracy in Study 2 when only a single premise was presented is also consistent with the view that some of the age-related performance differences in the present studies are due to variations in the effectiveness of encoding information.

Therefore, one factor contributing to the age-related differences in information availability appears to be a failure of adults in their 50s to register and encode relevant information. Of course it is possible that other, as yet unidentified, factors also contribute to the age differences in information availability observed in these studies. Whatever the source of the differences in information availability, the results of these experiments suggest that there are small to nonexistent age differences in the ability to integrate and combine information if that information is still available in memory.

Results from two other studies also implicate working-memory factors in the age-related differences in simple reasoning tasks. Light, Zelinski, and Moore (1982) presented sets of premises followed either by tests of those premises or by tests of statements implied by combinations of those premises. Age-related reasoning impairments were reported in several independent experiments. An additional finding that older adults had lower reasoning scores than young adults even when both groups performed equivalently on a recognition test of memory for the premises could be interpreted as being inconsistent with the view that working-memory factors contribute to the age differences in reasoning tasks. However, the ability to recognize previously presented information does not necessarily mean that the information was accessible in working memory during the reasoning process. This distinction is supported by the finding of Arenberg and Robertson-Tchabo (1985) that older adults were as accurate as young adults in recognizing whether a statement had been presented before (as in the Light et al. study), but they were less accurate when the decision involved judging whether the statement was true or false according to the previously presented information (analogous to the current studies). Taken in combination, therefore, the Light et al. (1982) and Arenberg and Robertson-Tchabo (1985) results seem consistent with those of these studies in suggesting that working-memory factors are involved in the age differences observed in at least relatively simple integrative reasoning tasks.

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Beutler, Levin, Tesser, and Miller Appointed New Editors, 1991–1996

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