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Meaningfulness and Problem-solving Performance by Younger and Older Adults[1]

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Younger and older adults solved reasoning problems in either abstract or meaningful form. Contrary to expectation, older adults did not differ on the two versions, but younger adults were aided by meaningfulness. Results of a second task showed no age differences in the time to produce associations to problem elements or in the number of associations. There were differences in the quality of associations, and association quality was significantly related to performance on the reasoning problems for older adults.

The effect of meaningfulness on problem solving by older adults has not received extensive attention in the cognition and aging literature. While there are several studies showing meaningfulness to enhance selectively older subjects' performance on learning and memory tasks [7; 8; 12], little has been reported about the consequences of offering older subjects abstract reasoning tasks made more meaningful, that is, more familiar and concrete.

One of the few studies that reports a relationship between older subjects' problem solving and increased task meaningfulness was conducted by Arenberg [1]. Researching age differences in concept-formation skills, Arenberg found that the test he had originally planned to use, which required subjects to monitor abstract dimensions of form, color, and quantity, proved too difficult for older subjects to execute. However, when Arenberg transformed these abstract dimensions into the more meaningful items of a meal (i.e., entree, beverage, and vegetable) older subjects performed the task with much greater proficiency. While Arenberg treated the effects of his meaningful task transformation as only a methodological incidental, Botwinick [2] suggests that Arenberg's study indicates an important age relationship between problem meaningfulness and problem solving for older adults.

The present study attempts to establish formally that reasoning tasks made more meaningful selectively benefit older persons. Raven's Progressive Matrices [13] was selected as the problem solving task. The Progressive Matrices was seen as particularly appropriate because of its reliable sensitivity to age differences in abstract reasoning [5], its functional similarity to Arenberg's task, and its suitability for increasing meaningfulness.

The age-related effects of meaningfulness were explored by administering two versions of a subset of items from the Progressive Matrices. One version contained a set of 12 matrices in their original, abstract form while the other version contained these same matrices transformed to be more meaningful. It was predicted that performance would be better on the meaningful version of the matrices than on the original version, and that the improvement with the meaningful versions would be greater for the older than for the younger adults.

A corollary concern of this study was to determine the relation between associations and age differences in problem solving. Associations are believed to mediate performance on a variety of learning and problem solving tasks [3; 9; 10; 11; 14]. It may be that older adults are less likely to generate associations to a task. Deprived of the benefits associations offer, they may solve problems less effectively. To investigate this hypothesis of age differences in associations, a task was administered in which associations were given to figures resembling those of the original, abstract Progressive Matrices. Three predictions were made regarding the association task. Older persons were expected to be slower than younger persons at producing a first association to each figure, and were expected to produce fewer associations in a 60 sec period. In the older group, a positive relationship was predicted to occur between the number of associations produced and problem solving performance.

Method

Participants

Participants were 14 men and 15 women aged 18 through 34 years (average age, 24.0), and 12 men and 10 women aged 58 through 84 (average age, 68.0). Younger participants were recruited from the general community, older participants were recruited through the City of Claremont (California) Senior Program. Participants were not asked to rate the state of their health, though all appeared in generally good health. In other studies using these same populations, older adults have given mean health ratings of 8.54 ($n = 82$) on a scale where 10 is excellent. Younger adults have given a mean rating of 8.60 ($n = 85$). Education in the older group ranged from some high school to graduate or professional degree; younger adults ranged from high school graduates to some graduate education. The modal education in both groups was some college.

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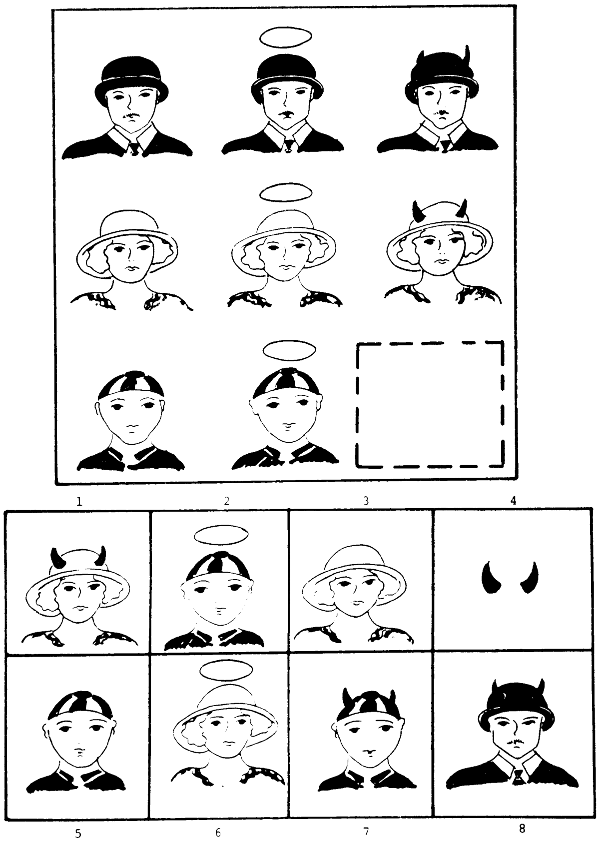

Figure 1. Example of the meaningful matrices. The problem shown corresponds to problem D-4 in the Standard Progressive Matrices.

Materials

Two matrices from the Progressive Matrices B set, used as practice problems, and the entire D set were administered in two versions. One version consisted of the matrices presented in their original, abstract form while the other version was made up of more familiar and concrete transformations of these same matrices. In these meaningful matrices, the abstract geometric figures drawn in black and white that comprise the original matrices were replaced with familiar objects in color. Every effort was made to ensure that the two matrix versions were structurally and conceptually identical. An example is shown in Figure 1. The matrix shown corresponds to D-4 in the Standard Progressive Matrices. Split-half reliability for the original matrices used here was .70 for younger adults, .82 for older adults; for the meaningful matrices, it was .61 for younger adults, .60 for older adults. The original and meaningful matrices were individually reproduced on 21.6 x 27.9 cm unlined paper, and placed in clip binders.

For the association task, four single components of matrix figures from the Progressive Matrices set E were enlarged so that each occupied most of a 21.6 x 27.9 cm sheet of unlined paper.

Procedure

Participants were tested individually, either at their homes or, for some of the older persons, at the Claremont Senior Center. The problem solving task was administered first; the free association task followed.

Eleven of the participants in the older age group and 15 of those in the younger group completed the meaningful version, while the others completed the original version. There were approximately equal numbers of men and women in each condition.

Participants were provided a test binder opened to the first practice matrix, were instructed how to complete the matrices, and then were supervised in the execution of the two practice problems. When the experimenter was assured that the task was understood, he instructed the participant to continue with the remaining matrices, and to take as much time as needed.

The association task was conducted immediately after completion of the problem solving task. Participants were instructed to produce as many associations as they could in 60 sec to each of the four figures. They were encouraged to write down whatever a test-figure brought to mind. When the individual was ready, the first figure was shown. The time between exposure of the figure and the first response was recorded with a stopwatch. After 60 sec, the individual was asked to stop writing and the figure was removed. This procedure was repeated for the three remaining figures.

Results

For the problem solving tasks, analysis of variance was carried out on the number of errors. Age group (younger or older) and version (abstract or meaningful) were between-subjects factors. The main effect of the version was not significant, $F(1,49) = .90, p<.05$. There was a significant difference between younger and older adults $F(1,49) = 42.15, p<.001$; older adults made more errors ($M = 6.32$) than younger adults ($M = 2.14$). There was also a significant interaction of age group and the version of the task, $F(1,49) = 4.68, p<.05$. Performance on the two tasks did not differ for older adults, $t(21) = .28, p>.05$ (for the meaningful problems, $M = 6.17$ errors; for the abstract problems, $M = 6.50$ errors.) The younger adults, however, made significantly fewer errors on the meaningful problems, ($M = 1.47$) than on the original problems ($M = 2.86$), $t(28) = 2.23, p<.05$.

Results of the association task showed no age differences in the total number of associations produced, $F(1,49) = 1.05$, $p>.05$, and no significant age differences in the average time to produce the first association, $F(1,49) = 3.03, p>.05$. The correlation between the number of associations and the number of errors was calculated for the older adults; no significant relation was found, $r(20) = -.14, p>.05$.

In contrast to these quantitative measures, there appeared to be age differences in the quality of the associations generated. Older individuals produced associations that seemed more fragmented and literal. Formal criteria for assessing fragmentation and literalness were developed from these informal observations. Associations were considered fragmented if they related to only one section of the figure from which they came (i.e., top or bottom, left half or right half). Literalness was attributed to associations that described a figure only in terms of its obvious geometric properties, and that offered no elaboration. The number of fragmented associations was significantly greater for older adults ($M = 1.60$) than for younger adults ($M = .48$), $F(1,49) = 5.52, p<.05$. Older adults also produced significantly more literal associations ($M = 1.91$) than did the younger adults ($M = .44$), $F(1,49) = 4.93, p<.05$. For the older adults there was a significant correlation between incidence of fragmented associations and the number of errors on the problem solving task, $r(20) = .38, p<.05$. There was no analogous correlation for literalness, $r = .07, p>.05$.

Discussion

Contrary to the predictions, meaningful transformation of the abstract Progressive Matrices did not enhance the performance of older problem solvers. The younger participants, however, were aided by increased meaningfulness. Why were older people not aided? One explanation is provided by Heron and Craik [6] and Craik and Masani [4], who found added meaningfulness in a learning task selectively benefitted younger adults. They concluded that the greater organizational demands inherent in increased task meaningfulness depress the older person's ability to profit from meaningfulness. The older problem solvers in the present study, then, may have been affected by the increased organizational demands generated by added problem meaningfulness. In support of this hypothesis, the meaningful matrices do have more extraneous detail.

Results from the association task failed to indicate any difference between age groups in quantitative measures of association. There are, however, qualitative differences in associational activity; older participants produced more fragmented and literal associations. The correlation between older participants' fragmented associations and the number of errors provides support for the claim that changes in associational ability interfere with the problem solving of older adults.

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