

Preliminary report on a technique for studying age-related performance deficits

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The performance of subjects ranging in age from 20 to 85 years was evaluated with a series of three simple, automated problem solving tasks. Age-dependent deficits were found in a task involving alternation of symbols, but not when spatial alternation was required. The technique described appears to be relatively free of bias and to provide a reliable, rapid, and sensitive procedure for further analysis of the determinants of age-related performance deficits.

The technique that we describe here was part of the first phase of a program designed to assess the prospect of pharmacological improvement in age-related performance deficits. Our interest was in developing a problem solving task that would be (1) minimally biased by language, cultural, and educational factors (thus, verbal learning tasks were not considered), (2) brief enough to minimize any differential effects of fatigue, (3) free of subjectivity in administration and scoring, (4) unbiased by differences in performance speed, (5) both motivating to the subjects and permitting of variations in reward for successful performance.

Our first attempt at developing a task with these characteristics proved to be especially promising. Our preliminary findings are described here.

METHOD

Subjects

Fifty-four volunteers (11 males and 43 females) participated in the experiment. Subjects' ages ranged from 20 to 85 years. Subjects were white, middle and lower middle-class males and females recruited from Rutgers Medical School staff and from local senior citizens groups. Level of education was uncorrelated with age and varied from high school to college.

Apparatus

Subjects sat before a panel (Lehigh Valley CSC-601 console) that contained two pushbuttons that could be independently transilluminated. Automatic programming and recording equipment was housed in an adjacent room; a one-way mirror in the wall between rooms permitted observation of the subjects.

Procedure

All subjects were asked to read and sign the following disclosure statement (witnessed by the research associate); a tape

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recording of the same instructions was played while the subject read them. These instructions were the only ones given during the experiment.

"You have been asked to participate in a study designed to test your ability to solve simple problems.

"When patterns or a white light show on the buttons in front of you, press one of them. If you have pressed the correct one, both buttons will show green; this means that you have earned \$0.05. If they show red, it means that you pressed the wrong one and that you have lost \$0.05. If this happens, try the other button. When neither button is lit, responses will have no effect.

"You will start with \$3.00. Remember, the more times a button turns green, the more money you will earn.

"There is no reason to hurry your responses—take as much time as you want. There is no element of risk, injury or illness from this procedure. The results of your performance will be kept confidential and not revealed in any way which can be an embarrassment to you.

"CMDNJ-Rutgers Medical School will provide free medical treatment at its own facilities for human subjects who suffer physical or psychological injury or illness as a direct result of participation in research activity conducted by CMDNJ. Monetary compensation for physical or psychological injury or illness is not available. You will be asked to sign this statement at this time."

The research associate then demonstrated the machine and determined that the subject could discriminate red, white, and green, as well as vertical and horizontal stripes projected on the buttons; she then left the room, and the program began. This program consisted of three phases: place alternation, delayed place alternation, and symbol alternation.

Phase 1: Place alternation. When both buttons were illuminated with white light, the subject was required to press one of them. If the first response was correct (indicated by green for a period of 1.0 sec), the next correct response was depression of the opposite button; the sequence of button illuminations would then be white, green (1.0 sec), white, etc. If the first response was incorrect, the buttons turned red for 1.0 sec and then white again; the subject was then required to depress the opposite button.

A block of trials consisted of 20 correct responses. The program was interrupted for 1.0 min at the end of each block, during which time the data were recorded. At the end of this time, the next block of trials was automatically begun. Phase 1 continued until (1) the subject met criterion by emitting correct responses in each of the last 10 trials of a block or (2) a maximum of five blocks had been completed, regardless of whether the subject had met criterion.

Phase 2: Delayed place alternation. Phase 2 began immedi-

ately following Phase 1 and was identical to that phase, except that delays were imposed following successive correct responses but not following incorrect responses. These delays were imposed between each correct response and the next illumination of the buttons; they were preprogrammed to be 0 (no delay), 5.0, 10.0, 15.0, and 20.0 sec and were imposed in sequentially increasing duration in each series of five trials. The sequence of delays was then reinitiated so that, in a block of 20 correct responses, there were four series of delays.

Blocks of 20 trials were continued until (1) the subject met a criterion of 10 successive correct responses or (2) a maximum of three blocks of trials were completed.

Phase 3: Symbol alternation. This phase was identical to Phase 1 except that the subjects were required to alternate symbols, not place. It began immediately following Phase 2 and did not involve additional instructions. These symbols (vertical vs. horizontal stripes) were randomly presented with respect to place.

Blocks of 20 trials were continued until (1) the subject met the criterion, (2) a maximum of five blocks had been completed, or (3) the number of incorrect responses accumulated was greater than 40.

All subjects were given additional exposure to other tasks. Because the findings of Phase 3 are most pertinent here, the results of the subsequent procedures are not reported. The data are available upon request.

RESULTS

The data obtained in the various phases of the experiment were arbitrarily grouped into three age ranges for purposes of statistical comparison. (These ranges were 20-39, 40-59, and 60+ years; the corresponding Ns were 17, 20, and 17.) This rather coarse grouping was chosen so as to increase statistical power.

None of the subjects failed to meet criterion in Phase 1, as shown in the top row of Table 1. There was, on the other hand, a suggestion of an age-related deficit in Phase 2, as shown in the second row of Table 1. This difference was not, however, statistically significant (by chi square).

This lack of difference is undoubtedly due to the fact that the subjects used mediating behaviors during the delays involved in this phase. (These were usually anticipatory hand placements near the to-be-correct button.) More to the point, the numbers of subjects

Table 1
Percentages (P) of Subjects Failing to Reach Criterion

Phase	Age Range (in Years)					
	20-39		40-59		60+	
	P	N	P	N	P	N
1	0	0/17	0	0/20	0	0/17
2	6	1/17	15	3/20	24	4/17
3	53	9/17	55	11/20	94	16/17

Note—N = number of subjects; 1 = place alternation, 2 = delayed alternation, 3 = symbol alternation.

using such mediating behaviors differed among the groups: 5.8%, 15.0%, and 41.2% for the 20-39, 40-59, and 60+ groups, respectively. [These percentages differ reliably; $\chi^2(2) = 7.02$, $p < .05$.] This difference indicates that, with increasing age, the greater use of positional cues can effectively compensate for a deficit that might have been detected had such cues not been available. Thus, the imposition of delays did tend to reveal age-related differences, but this effect was counteracted by the use of mediational behaviors.

The results obtained in Phase 3 are shown in the third row of Table 1. In this task, in which overt mediational behaviors are not available, the percentage of subjects reaching criterion did reliably differ among the groups [$\chi^2(2) = 8.42$, $p < .02$].

DISCUSSION

The technique described here reveals age-related deficits and meets the criteria outlined above. That is, it is relatively uncontaminated by major bias, is brief (Phases 1-3 required about 25 min), and provides for variation in monetary reward.

The deficits seen in Phase 3 may, of course, have been due to proactive interference from the preceding phases; only a separate experiment can address that possibility. If proaction does determine the deficit, it will then be possible to explicitly examine the role of prior experience in determining age-related deficits seen in Phase 3 as well as the effects of motivation engendered by variations in reward.

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