Bulletin of the Psychonomic Society
1985, 23 (6), 437-439

Acquisition and retention of a verbal habit in early and late adulthood

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Two groups of subjects, adults in their 30s and 60s, learned a set of paired associates and then recalled the second member of each pair on seeing the first over the course of many trials. There were marked effects of practice and of age, but no interaction between those two variables. The older subjects' performance did not decline disproportionately after a 2-week retention interval. After extensive practice, the younger subjects took almost the same amount of time to name a word's associate as to name the word itself, while the older subjects took markedly longer to name a word's associate than to read the word aloud. This seemingly irreducible difference in latencies is attributed to less efficient retrieval from memory by the older subjects.

Earlier work (Waugh, 1969) has shown that with extended practice, young adults markedly reduce the time taken to pronounce the second member of a newly associated pair of words upon seeing the first: initially retrieval is from a slow-access store and takes much longer (Waugh, 1970) than retrieval from immediate memory. After intensive practice, however, young adults take less time to recall a familiar associate after a 24-h retention interval than to retrieve from primary memory a novel associate that they have just seen (Waugh & Holstein, 1968). It is as though information were transferred via repeated retrieval from a store in which it has to be searched for into one where it is readily available.

Although older subjects are generally slower than young ones to perform almost any mental operation (Waugh & Barr, 1980), both groups nonetheless acquire at the same rate the sort of habit described above (Waugh, 1980). Waugh (1980) found that older subjects were initially slower than younger ones, but evidently improved at the same rate. It was unclear whether they had reached their asymptotic level of performance after 12 blocks of trials. Whether they had is a point of theoretical importance. If the functions relating response time to number of trials should eventually converge, then it can be concluded that the older subject's rate of learning indeed falls below that of the younger adult. If, on the other hand, the curves remain parallel and reach different asymptotes, then it can be concluded that the older subject's maximal level of performance differs from that of the younger one, even though their respective rates of learning are the same.

The present study was carried out to determine whether older subjects who perform a paired-associate task will, after extended practice, eventually become as proficient as younger ones, or whether there is some irreducible difference in asymptotic response latencies between the two groups. A second purpose of this study was to determine whether a newly learned skill is equally well retained by members of both age groups over a period of two weeks.

This work was supported by the Social Science Research Council (U.K.). Subhash Vyas gathered the data: he and Robin Barr helped analyze them. Burton Rosner made many useful suggestions. Requests for reprints should be addressed to Nancy C. Waugh, Department of Experimental Psychology, University of Oxford, South Parks Road, Oxford OX1 3UD, England.

METHOD

Subjects

Two groups of subjects, paid volunteers, participated in the experiment. All were community-dwelling adults. Four were in their 30s (mean age: 33.5) and 4 were in their 60s (mean age: 64.5). They were matched for general intelligence as measured by Raven's matrices (90th percentile or higher for their respective age groups), and for years of formal schooling. All were in good health and possessed normal or corrected-to-normal vision. Two members of each group were men and 2 were women. All subjects had served in a previous choice reaction-time experiment. On the basis of their performance in that study, they were selected as being representative of their age groups. Within-group variability was thereby minimized.

Materials and Apparatus

The material to be memorized consisted of 12 paired associates made up of common three-letter English nouns related to each other in no obvious semantic way and selected on the basis of acoustic and visual discriminability. The members of each pair began with consecutive letters of the alphabet, and every word began with a different letter. Examples of the pairs are: *ace-boy, car-dog, vat-wig, yam-zoo*. Each pair was typed in lower Roman case onto an index card. In addition, both the first and the second member of each pair was typed individually onto a card. Each of these 24 cards was photographed and reproduced as a 5 × 5-cm slide.

The subject sat comfortably in a sound-insulated room approximately 3 m away from a screen. The slides were projected onto the screen by means of a Kodak Carousel projector. The subject spoke his or her responses into a microphone which was on a table in front of him or her. Response latency—defined as the time elapsing from the onset of the projection of a slide to the triggering of a voice-operated relay—was measured to the nearest millisecond. Stimuli were presented and latencies were recorded with the aid of a DEC PDP-8/I computer.

Procedure

Subjects were tested individually over the course of two 1-h sessions separated by a 2-week interval. The first session began with 3 blocks of trials. In each block, the subject read aloud 12 different words. The same words occurred in each block. These words were the second members of the pairs which the subject would later memorize. They were ordered unsystematically, subject to the constraints that (1) each appear exactly once within trials 1-12, 13-24, and 25-36; and (2) no word ever follow itself in immediate succession. The subject was instructed to respond both as rapidly and as accurately as possible. The experimenter monitored any accidental triggerings of the voice key. Response latency is operationally defined as the time required to retrieve information from lexical memory (Waugh, Thomas, & Fozard, 1978)—namely, the time taken to initiate a highly overlearned, "compatible" verbal response on cue. This initial procedure accordingly served two purposes: it permitted a baseline response time to be determined, and it allowed the subject to become familiar with the main experimental task. There was no indication of a practice effect across the three blocks of trials.

The subject next studied the pairs on the index cards at his or her own pace until he or she could recite them perfectly on two consecutive trials. He or she then underwent nine blocks of 12 retention trials. On each trial the subject was shown the first member of a pair. He or she had been instructed to respond by naming the second member of that pair as rapidly and accurately as possible. A new item was projected 2 sec after the subject's oral response. Within a given block, each of the 12 stimuli was presented exactly once. Otherwise they were ordered unsystematically, subject to the constraint that at least 2 other stimuli should appear between successive presentations of a given item. The order differed from block to block. Every subject, however, saw the same sequence of stimuli. The experimenter again monitored any accidental triggerings of the voice key and also noted incorrect responses. Approximately 15 min elapsed between Blocks 3 and 4 and between Blocks 6 and 7. The remaining blocks followed continuously one after the other.

The second session was devoted entirely to testing retention in a further nine blocks of 12 trials. New stimulus orderings were used. Again, a 15-min break occurred after the third and after the sixth block.

RESULTS AND DISCUSSION

Errors and equipment failures occurred less than 5% of the time for both age groups. Response times associated with errors were discarded.

The data are summarized in Figure 1, where the geometric mean response latency calculated for each age group is plotted as a function of the number of trial blocks. Each point is based on a maximum of 48 observations (4 subjects per group × 12 trials per subject).

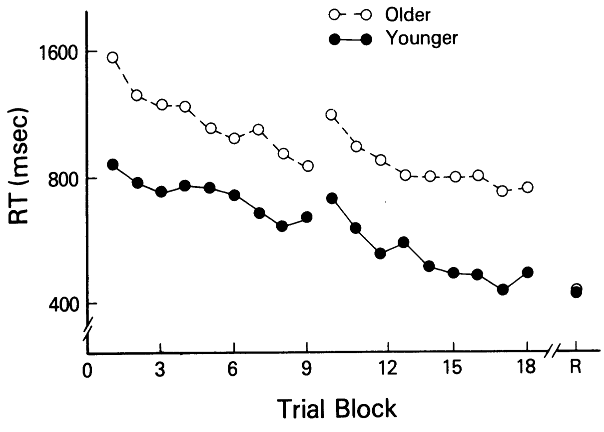

Figure 1. Mean time for recalling an item on cue as a function of practice for two age groups. The two rightmost points represent the time taken to read a word aloud.

Two facts are immediately obvious. First, both groups improved at approximately the same rate after the second block of trials. Mean response time for the older subjects on the first trial was 1,591 msec. It was 861 msec for the younger group, for a difference of 730 msec. The mean difference narrowed to 484 msec on the second block and remained more or less constant thereafter. Second, retention losses over the 2-week interval were not markedly greater for the older subjects than for the younger ones. The difference between the two groups' mean response times was 429 msec on block 10, the first block of the second session. The mean difference across all blocks of trials was 386 msec, with a standard deviation of 117 msec.

These points were borne out by the results of a split-plot analysis of variance performed on the logarithmic transforms of the individual subjects' mean response times for each block of trials. The differences between age groups were significant [$F(1,6) = 10.73$, $p < .025$], as was the main effect of trials [$F(17,102) = 17.08$, $p < .001$]. The interaction between chronological age and blocks of trials, however, fell far short of significance [$F(17,102) < 1$]. These results are in keeping with those reported by Waugh (1980).

Both groups appeared to have approached a stable level of performance by the 12th block of the trials. Tests of linear, quadratic, and cubic trend across the last 5 blocks for each group supported this inference [$F(1,15) < 1$ in all cases]. This result is consistent with data reported by Grant, Storandt, and Botwinick (1978), whose subjects performed a symbol-substitution test.

The two rightmost points in Figure 1 denote baseline "reading time" for the two age groups, obtained at the beginning of the first session. The points virtually coincide. This finding represents an exception to the "mental tempo" principle put forth by Waugh and Barr (1980), according to which older adults are generally slower than younger ones on cognitive or psychomotor tests. On the final block of trials in the present experiment, the younger subjects' response times were effectively equal to the baseline reading time, a result consistent with those of Waugh and Holstein (1968). Clearly, this was not the case for the older subjects. It is of course possible that, despite the lack of a statistically significant trend across the last five blocks of trials in the present study, the older subjects would have improved with futher practice. A power function (Newell & Rosenbloom, 1981) was therefore fitted to these data. Extrapolation to the baseline reading time showed that the older subjects would have needed from 1,000 to 55,000 additional blocks of trials to achieve that level of performance. Such slow improvement would be of no practical significance.

For the young adult, then, the time taken to retrieve the second member of a pair from memory had fallen to a negligible amount by the end of the experiment. The response seemingly had become automatic. The older subject, on the other hand, still required an extra 330 msec to recall an item on cue, over and above the time taken simply to read a word aloud. And yet, in accordance with previous findings (Waugh & Barr, 1980; Waugh, Thomas, & Fozard, 1978), older and younger subjects took almost the same amount of time to read a familiar word aloud. The older subjects' impairment, then, is in efficiency of retrieval and not in speed of perception or response selection. This difference between younger and older subjects indicates yet another instance of the "mental tempo" principle (Waugh & Barr, 1980).

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(Manuscript received for publication July 26, 1985.)