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Eighteen young (almost 16 years of age) and 18 old (average age 70) subjects were assigned to either the control or one of two experimental groups on the basis of their age, sex, vocabulary, and need for achievement scores. All participated in a test session and two experimental sessions. Results indicate that (1) Items that have been often experienced and are repeatedly represented in the storage system of a subject are recognized faster than items that have been experienced less often. (2) For subjects with large accumulated repertoires (old subjects), the effects of experience with new items of varying frequencies will be relatively less marked than for subjects with smaller repertoires (young subjects). Keeping all other factors constant, their recognition thresholds for such new items are higher than for young subjects. (3) There seem to be age differences in long term need states as measured by the need for achievement test. Old subjects seem to rearrange items at a lower speed than young subjects and consequently have lower achievement test scores. (4) Need-arousing instructions hinder the performance of old subjects, but improve the performance of young ones. Because of their large storage, old subjects seem to become confused rather than being supported by this influence. The authors also discuss the need for further research and the implications of such research (DO)

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by

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The Effects of Word Frequency, Need for Achievement, and Instructional Sets Upon Recognition Thresholds of Young and Old Subjects

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Differences in word recognition thresholds are in part due to stimulus properties, and in part to the internal status of the organism. During the past two decades much interest has been directed toward the latter factor. Thus, Postman, Bruner, and McGinnies (1948) showed that value preference has an effect on the speed of recognition of value related words and suggested the concepts of sensitization and perceptual defense for the explanation of their findings. Their interpretations were challenged by Howes and Solomon (1951), however, who emphasized that word frequency accounted for a greater part of the variation than word related motivation. Still more recently, the present authors (Riegel and Riegel, 1961) have shown that words denotating perceivable objects have lower thresholds than words without concrete referents. Again, speed of recognition may depend on the frequencies with which Ss have experienced the referent objects and/or the words denoting them.

In reviewing the main problems in this field of research, Postman (1953) distinguished three basic variables: frequency of experience, situational properties, (as induced by special instructions) and organismic properties denoting long-term need states (e.g. need for achievements) and short-term or physiological need states, (e.g. hunger). The effect of experience was most clearly revealed in studies of word recognition and when the frequencies were directly manipulated prior to the measurement of thresholds by acquainting Ss at varying degrees with nonsense syllables. The effects of situational properties and long-term need states, on the other hand, were commonly investigated by using real words, i.e. under conditions in which frequency could not be readily manipulated by E, except by the rather crude control of the Thorndike-Lorge frequency counts (1944).

Since long-term need states will affect Ss long before the experiment takes place, this variable will have a differential effect upon an individual's word-frequency distribution. For instance, an achievement motivated person will have had a greater amount of experience with achievement related words than a person with low need for achievement . Subsequently, the distributions of word-frequencies will vary between persons. Long-term need states, thus, may be reduced to variations in the individuals' frequency distributions. Since it is unlikely, however, that such a reduction can be complete, differences in long-term need states may still have sizeable effects upon the speed of perception. This will be especially true when past experience is controlled by using nonsense material or when needs are aroused by special instructions.

In an exploration of these questions, the following variables and their interactions have been studied in the present word recognition experiment:

1. frequencies of experience by using paralogs as stimuli with which Ss were acquainted at varying degrees;
2. long-term need states controlled by special selection of Ss on the basis of the McClelland's need for achievement test;
3. short-term need states aroused by instructions and directed toward specific goals related to the stimuli used, and given either (a) prior to the learning of the paralogs or (b) prior to the measurements of the thresholds.

Since the amount of experience increases with age, both frequency and need for achievement ought to have a different effect upon old and young adults. In an attempt to explore this problem, the experiment was conducted on samples of young and old Ss. Ss were matched for sex and vocabulary scores, but it was questionable whether long-term need states (item 2 above) could also be controlled in this manner. Differences in age may well make such a control impossible in that old Ss may attain systematically lower scores than young Ss. Related evidence seems neither available in the literature nor can the present study -- because of the limited number of persons sampled -- provide detailed answers to this question.

Under all conditions, old Ss were expected to have higher thresholds than the young. A differential effect upon the thresholds due to the other manipulations was also anticipated. When need arousing instructions were given prior to the learning of the paralogs (item 3a) the relative deficit was expected to be larger than when the instructions were given just prior to the measurement of the thresholds (item 3b). In the former case, both recall and recognition are involved, but in the latter only recognition factors. Because of their known deficiencies in short- and long-term retention, frequency of exposure to new stimuli (item 1) was expected to influence the performance of old less markedly than that of young Ss.

Procedure

All Ss participated in a test session and two experimental sessions. Approximately three to four weeks elapsed between the test session and the first experimental session, and exactly one week between the first and second experimental sessions. After the test session Ss were assigned to two experimental and one control group which differ in regard to the instructions to be given.

Test session: A vocabulary test consisting of 20 multiple choice items (Riegel, 1959, 1967b) and the pictures 1, 2, 7 and 8 of the need for achievement test (Atkinson, 1958, p. 832) were administered to the Ss under standard instructions.

First experimental session: After a brief description of the apparatus the following instructions (translated from German) were given to all Ss:

> "When you press that button, a nonsense word will appear on the illuminated screen. Your task is to recognize the word and to tell me after each trial what you have seen. I will inform you when you may push the button."

Following preliminary trials on two paralogs the thresholds for five paralogs were measured. Afterwards a deck of cards including ten paralogs at varying frequencies and the following instruction were given to Ss of the control (C) and the first experimental group (MT), i.e. the group for which measuring of the thresholds was to be motivated:

"Please read and spell every word aloud. There is no particular hurry." To Ss of the second experimental group (ML), i.e. the group for which the learning of the paralogs was to be motivated, the following instruction was given:

> "What you did so far has helped us to select proper words and to find out whether the apparatus works alright. The following task, however, will be used for an evaluation of your intelligence. Thus, do the best you can. Today, you have to read and spell the words on these cards only. We shall return, however, to this task and thus become able to evaluate your intelligence. I rather wanted to tell you this in advance so that you may do the best you can."

Second experimental session: To Ss of the control (C) and the second experimental group (ML) the following instruction was given before the thresholds of the ten paralogs were measured:

> "Now you are already well acquainted with the procedures. We want to select proper words from our collection and appreciate if you would help us."

To Ss of the first experimental group (MT) the following instruction was given:

> "You are already well acquainted with the procedures. So far you have helped us to select proper words. Now, your achievements are important which allow us to evaluate your intelligence. I rather wanted to tell you this in advance, so that you may do the best you can."

Subjects: Eighteen young and eighteen old Ss were used and assigned either to the control (C) or the two experimental groups (MT, ML) on the basis of their age, sex, vocabulary and need for achievement scores. The young Ss were students of a skilled-trade school. The old Ss were residents of a home for the aged, however, they were without any gross physical or mental disabilities. There was an equal number of males and females in all groups. In the assignment of Ss to one of the three groups according to their need for achievement scores the findings of Moulton, Raphelson, Kristofferson, and

Atkinson (1958) were applied, who have reported that achievement arousing instructions are effective only in the case of Ss with high test scores. Accordingly, only Ss with high scores were assigned to the experimental groups (MT, ML), whereas those with low scores were assigned to the control group (C). Accordingly, long-term need states (test scores) and instructional factors are confounded in most of our comparisons. Since sex differences were found to be negligible, they will be disregarded in the following discussions. The average age of Ss in the three young groups (C, MT, ML) was 15.9, 15.8 and 15.9 years and in the three old groups 70.0, 71.5 and 68.5 years, respectively.

Material: All paralogs consisted of three consonants and two vowels arranged in the order CVCVC. The ten paralogs used in the second experimental session were taken from Woodworth and Schlossberg (1954). Seven additional paralogs used during the first experimental session were constructed by the authors. Two of them were given as introductory trials, the other five for estimating the average recognition speed of Ss under conditions uninfluenced by experimental manipulations. The acquaintance of Ss with five pairs of paralogs was varied by arranging their frequencies of occurrence in decks of cards which Ss had to read and spell during the first experimental session. The frequencies increased in the following steps: 1, 2, 5, 10, and 25. Five different decks of cards were used. Thus, each pair of paralogs appeared at all the five different frequencies. For each S a particular deck of cards was randomly chosen. The cards were randomized in each deck. In addition ten dummy words were included in each deck. The verbal associations collected from twelve young Ss in a pilot study did not reveal any systematic differences between the paralogs.

Apparatus: The tachistoscope resembled that of Dodge-Gerbrands. All paralogs were typewritten in capital letters on 6 x 9 cm translucent slides leaving one blank space between adjacent letters. The paralogs appeared at the center of the visual field which was illuminated in a light reddish color, due to the particular neon bulbs used. The screens were located at a distance of 30 cm from S's eyes. S pushed a button to release the stimulus but E could override and parallel S's actions. In order to eliminate fluctuations in accomodation and adaptation, the exposure of the words was followed after less than 1 msec. by the exposure of a blank screen under the same illumination. Ss were also instructed not to remove their faces from the eye-shade.

Recordings: All responses were recorded by E. Ss had to recognize each paralog correctly three times in a row providing the last response was given with certainty and no further trials were requested by Ss. The third from the last measure was regarded as the threshold. For young Ss, the exposure time was increased in equal steps of approximately 10 msec. (or exactly 5 scale units on the apparatus timer), beginning with the lowest exposure time of 50 msec. The two preliminary trials were used in particular to determine the lowest exposure time for the old Ss. This was necessary, since the mean recognition thresholds were much higher and more variable among the old. By increasing the exposure time in equal steps of approximately 20 msec. (or exactly 10 scale-units), and beginning at an individually higher level than the lowest level of 50 msec., we succeeded in presenting all stimuli about equally often to young and old Ss.

Results

The data have been analyzed in terms of the differences between the sums of recognition thresholds (in scale-units) of each of the pairs of five paralogs with varying frequencies ($i = 1, 2, 5, 10, 25$) and the sums of the mean recognition thresholds of the five paralogs with zero frequencies. In these computations a weight of two-fifths was given to the sums of the recognition thresholds of the paralogs with zero frequencies. The results are shown in Table 1.

Insert Tables 1 and 2 about here

Type I designs of an analysis of variance (Lindquist, 1953) have been applied separately to the data of the young and old Ss. Word frequency was found to lower significantly the thresholds of young Ss ($F = 4.51$; $dF = 4/60$; $p < .005$), whereas, the effect of the instructions was of borderline significance ($F = 3.15$; $dF = 2/15$; $p < .08$). The interaction effect failed to meet this criterion. Paired comparisons of the thresholds for the two experimental and the control groups of young Ss (see Table 2) show that motivated learning (ML) facilitates recognition in comparison to the other groups (C and MT). Motivated recognition seems to hinder rather than to facilitate the recognition of paralogs. However, the deviation from the control group (C) falls sligtly short of being statistically significant. The correlations between the logarithms of word frequencies and mean thresholds are lower than those reported in earlier studies. This had to be expected since a longer time, namely seven days elapsed between our two sessions, whereas in earlier studies (King-Ellison and Jenkins, 1954), the intermission period was only of 20 min. duration. Although, not statistically significant, the differences between the correlations suggest that Ss who were motivated prior to the recognition task (MT) made slightly less use of the word frequencies training than Ss of the other groups.

The analysis of variance has been repeated for the data of the old Ss. Here, neither word frequency and instructions nor the interaction effect are significant. In paired comparisons (see Table 2) the mean thresholds of the control group (C) is significantly lower than those of the experimental groups (ML, MT). Thus, motivation seems to hinder rather than to facilitate the speed of recognition among old Ss. The correlations between the logarithms of the word frequencies and mean thresholds are lower although not significantly lower than those of the young Ss. The differences in correlations between the three groups are similar to those of young Ss. Again, Ss who were motivated prior to the recognition task (MT) seem to make the least use of the word frequency training which they had received in the first experimental session.

As shown in the first six columns of Table 1, there is no overlap in absolute thresholds of young and old Ss and, thus, all differences are highly significant. Of greater importance for our interpretations are the age effects upon the difference scores shown in the last three columns of Table 1. The age difference in difference scores for the experimental group (ML) ($p < .001$) but not the experimental groups MT nor for the control groups C are significant. Since the last of these comparisons is indicative of age difference in the "pure" effect of word frequency on thresholds, i.e. the effect uninfluenced by motivation arousing instructions, recognition speed of young as well as of old

Ss seems to be similarly affected. The magnitude of this effect is not exactly equal, however, as the differences in the correlations between the logarithms of word frequencies and thresholds have suggested.

Discussion

For a comprehensive interpretation of the results we specify a system intervening between stimuli and responses in which elements of past experience are being accumulated in proportion to the frequencies with which they have occurred to Ss. These elements are not stored like books on a shelf, but are continuously rearranged during the overt or covert activities of Ss. The average speed of these rearrangements characterizes the inner state of the organism and corresponds to his level of activity, drive or motivation. Finally, the speed with which incoming data are decoded depends on the past history and the inner state of the organism. Thus, Ss are more likely to make correct guesses and to perceive those stimuli at a fast rate that have been frequently experienced in the past. Perception will be also facilitated the higher the speed with which the stored elements are rearranged within the system at the time of testing.

On the basis of this model and in reference to the hypotheses stated in the introduction, the following conclusions may be drawn.

(1) Items that have been often experienced and are repeatedly represented in the storage system of a S are recognized faster than items that have been experienced less often. This finding confirms earlier results even though, in our study, one week rather than 20 min. elapsed between the training and testing of S.

For Ss with large accumulated repertoires, i.e. old Ss, the effects of experience with new items of varying frequencies will be relatively less marked than for Ss with smaller repertoires, i.e. young Ss. Keeping all other factors constant, their recognition thresholds for such new items are higher than for young Ss. This finding is supported by various other results of verbal performances (see Riegel, 1966, 1967a).

(2) There seem to be age differences in long term need states as measured by the need for achievement test. Old Ss had lower achievement test scores i.e. they seem to

rearrange items at a lower speed than young Ss. Because of the limited number of Ss tested, this difference may be due to sample biases, however, and would require further confirmation.

(3) Need arousing instructions hinder the performance of old, but improve the performance of young Ss. In previous research (Riegel, Riegel, and Wendt, 1962) a similar, negative effect was observed when a cognitive rather than a motivational set was induced by instructions. In terms of our model, motivation arousing instructions ought to increase the speed with which perceptual hypotheses are posed and checked by Ss. Because of their large storage, old Ss seem to become confused rather than being supported by this influence.

(a) When need arousing instructions are given to young Ss prior to the learning of the paralogs (ML), these items will be incorporated into their repertoire with special tags or speed markers. Subsequently, they will be better retained and are more likely than all the unmarked items to be posed and confirmed as perceptual hypothesis in the recognition part of the experiment. Subsequently, the thresholds are reduced in comparison to the control condition.

(b) When need arousing instructions are given to young Ss prior to the measurement of the thresholds (MT), the effect will be diffuse and not limited to the paralogs studied one week earlier. Subsequently, there is no reduction in thresholds. (Indeed a slight increase has been observed.)

(2 and 3) On the need for achievement test, both experimental groups at both age levels had higher average scores than the control Ss. Thus, the findings mentioned under 3a and 3b for young Ss could be the joint result of the differences revealed by the test scores and those induced by the motivation arousing instructions. Since the difference between the young control group (C) and the experimental group to which the motivation instructions were given prior to the measurement of the thresholds (MT) was negative, neither high test scores nor instructions seem to facilitate performance. On the other

hand, high test scores alone are unlikely to explain the very marked improvement in performance when motivating instructions are given prior to the learning of the paralogs (ML), because the two experimental groups do not differ in test scores from one another. For old Ss the differences between the control group and the two experimental groups were negative in both cases and, thus, high test scores or induced motivation (or both) hinder rather than facilitate performance.

Although conceivable, it would be premature to stretch our model at this point in order to account for the interaction between long-term need states, motivation arousing instructions and age. It seems more important to direct additional research toward this problem and, perhaps, to consider also the influence of age differences in anxiety levels on performance. If systematic age differences in long term need states were confirmed, serious methodological problems will arise. As previously discussed (Riegel, Riegel and Meyer, 1967), the investigator will be faced with the difficult decision whether to study age differences of the effect of motivating instructions either by controling or by confounding age differences in test scores. If, in the former case, we were to match young and old Ss in terms of their test scores the sample of old Ss will be highly selected and biased. In the latter case, difficulties will arise in unconfounding the influence of the two experimental factors and age.

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Footnote

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Table 1

Sums of recognition thresholds over six Ss in scale units for pairs of paralogs with varying frequencies ($i = 1, 2, 5, 10, 25$), weighted sums of recognition thresholds for five paralogs with zero frequencies ($i = 0$), means ($\bar{X}$) and standard deviations (SD) of difference scores, and correlations between sums of recognition thresholds of paralogs and the logarithms of frequency for three groups of young and old Ss.

Group		25	10	5	2	1	0	$\bar{X}$	SD	r
Young	Control C	290	270	295	345	405	700	-247	54.4	-.87
	Exper. MT	220	230	205	295	285	576	-195	40.2	-.79
	Exper. ML	175	255	220	255	355	744	-378	65.9	-.86
Old	Control C	985	1095	1080	1055	1415	1734	-608	149.4	-.76
	Exper. MT	1620	1810	1840	1805	1735	2042	-280	79.9	-.43
	Exper. ML	1955	1925	2000	1990	2235	2130	-109	110.2	-.78

Table 2

t-values for differences in transformed mean recognition thresholds for the young and old groups.

Group	Young	Old
Control C - Exper. MT	-1.70	-2.09*
Control C - Exper. ML	3.42***	-2.92**
Exper. MT - Exper. ML	5.28***	-1.46

* $p < .05$
** $p < .01$
*** $p < .001$