COMPARISONS OF POPULATION SUBGROUPS PERFORMANCE ON A KEYBOARD PSYCHOMOTOR TASK

Robert L. Stapleford*
Systems Technology, Inc., Hawthorne, California

ABSTRACT

Response time and pass/fail data were obtained from 163 subjects performing a psychomotor task. The basic task comprised a random five digit number briefly displayed to the subject at the start of each trial, and the keyboard on which the subject was to enter the number as fast as he could accurately do so after the display was extinguished. Some tests were run with the addition of a secondary task which required the subject to respond to a displayed light appearing at a random time.

Matched pairs of subjects were selected from the group to analyze the effects of age, sex, intelligence, prior keyboard skill, and drinking habits. There was little or no effect due to age or drinking habits. Differences in response time were: average IQ subjects faster than low IQ subjects by 0.4 to 0.6 sec; subjects with prior keyboard skill faster by 0.4 to 0.5 sec; and female subjects faster by 0.2 to 0.3 sec. These effects were generally insensitive to the presence of the secondary task.

TASK

At the initiation of the task, a random five digit number was displayed to the subject for [illegible] sec. After the light was extinguished the subject was to enter the number on an adding-machine-like keyboard. He was instructed to enter the number as rapidly as he could without making an error.

The task was done with and without a divided attention task (DAT). For the DAT [illegible] light came on at a random time within a window of 1.0 to 4.0 sec after the five digit number was extinguished. The subject then had 3.0 sec to extinguish the DAT light by pressing a foot pedal.

For each trial the following data were recorded:

- Primary reaction time — time to enter five digit number
- Secondary reaction time — time to respond to DAT if present
- Pass or fail — failures were due to entering the wrong number, not completing the DAT in time, or starting to enter the number too soon

* Principal Research Engineer.

Subjects were recruited at offices of the California Motor Vehicle Department and Human Resources Development. Each subject who was accepted was given a drinking-profile test (based on NIMH-HEW studies) and a short IQ test. They were then briefed on the purpose of the experiment and the details of the task. They were then given approximately 63 trials on the task without the DAT. The first 15 trials were excluded from the subsequent data analysis. They were then briefed on the operation of the DAT and given another 63 trials on the task with the DAT. The first 10 trials of this second set were also excluded from the data analysis.

GROUP COMPARISONS

This section describes the analysis of the differences among various subsets of the subject population. The analysis was specifically done to determine if there are any systematic effects of differences in subject intelligence, keyboard skill, sex, drinking habits, and age. For each of the five comparisons, matched pairs of subjects were selected. For example, in the comparison of average and low IQ subjects the low IQ subjects were isolated first, as this was the smaller subset of the population. We then attempted to match each low IQ subject with an average IQ subject. The matching was done on the basis of the other four factors, i.e., keyboard skill, sex, drinking habits, and age. Low IQ subjects which could not be matched on the other four factors were dropped from the comparison. Thus for each comparison we had matched pairs of subjects, where the matching was done over four factors and the effects of the fifth were then tested.

In each group comparison several parameters were analyzed. These included mean reaction times and standard deviations for the group. Here we considered the primary reaction time with and without the DAT and also the DAT reaction time. In addition to the mean and standard deviation, a histogram of the group reaction time was obtained. Examples of these histograms are shown in Fig. 1.

While the group histograms are interesting as an indication of population characteristics, they are not too informative about the population members. The problem is whether the group distribution is due to the

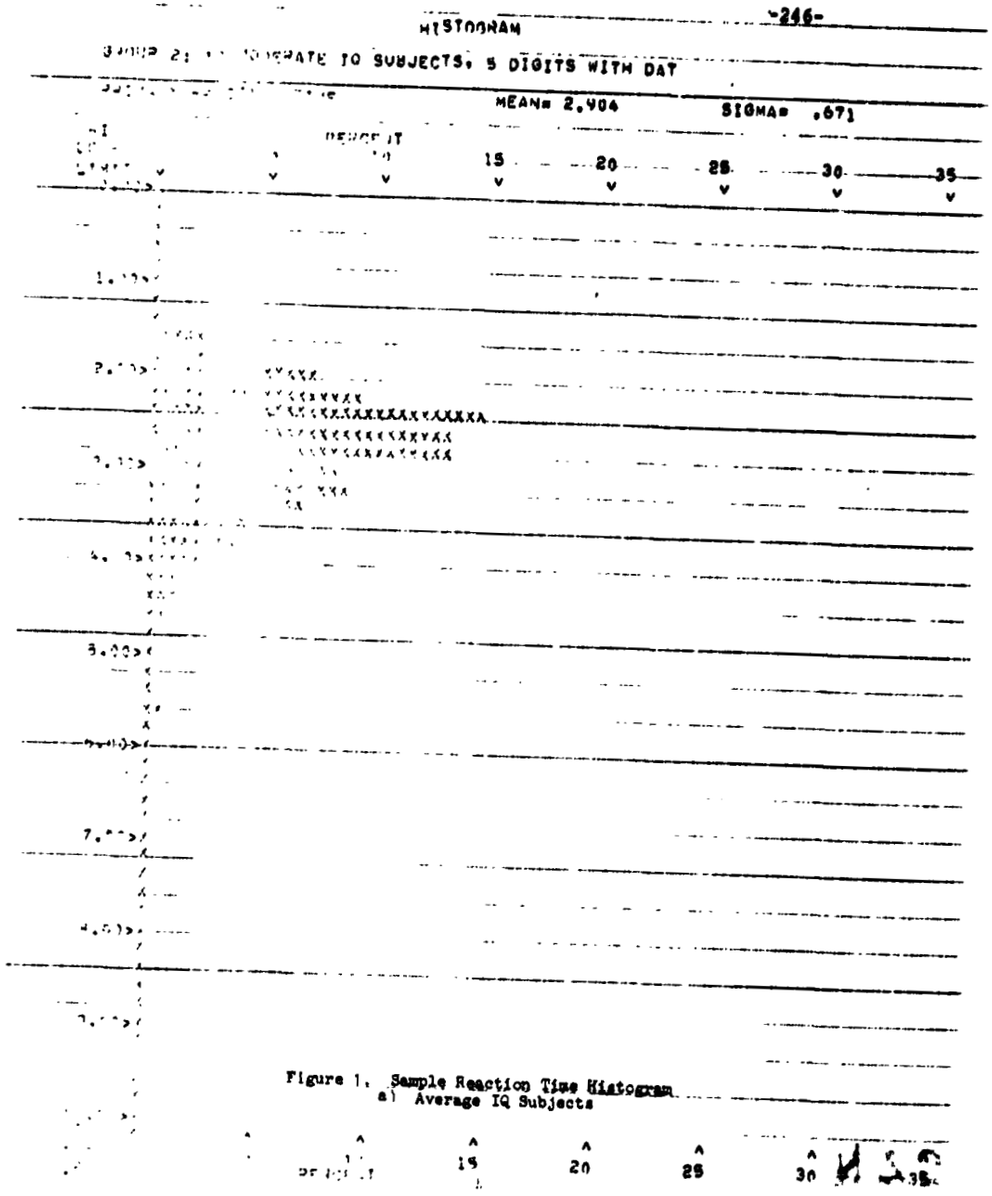

Figure 1. Sample Reaction Time Histogram
a) Average IQ Subjects

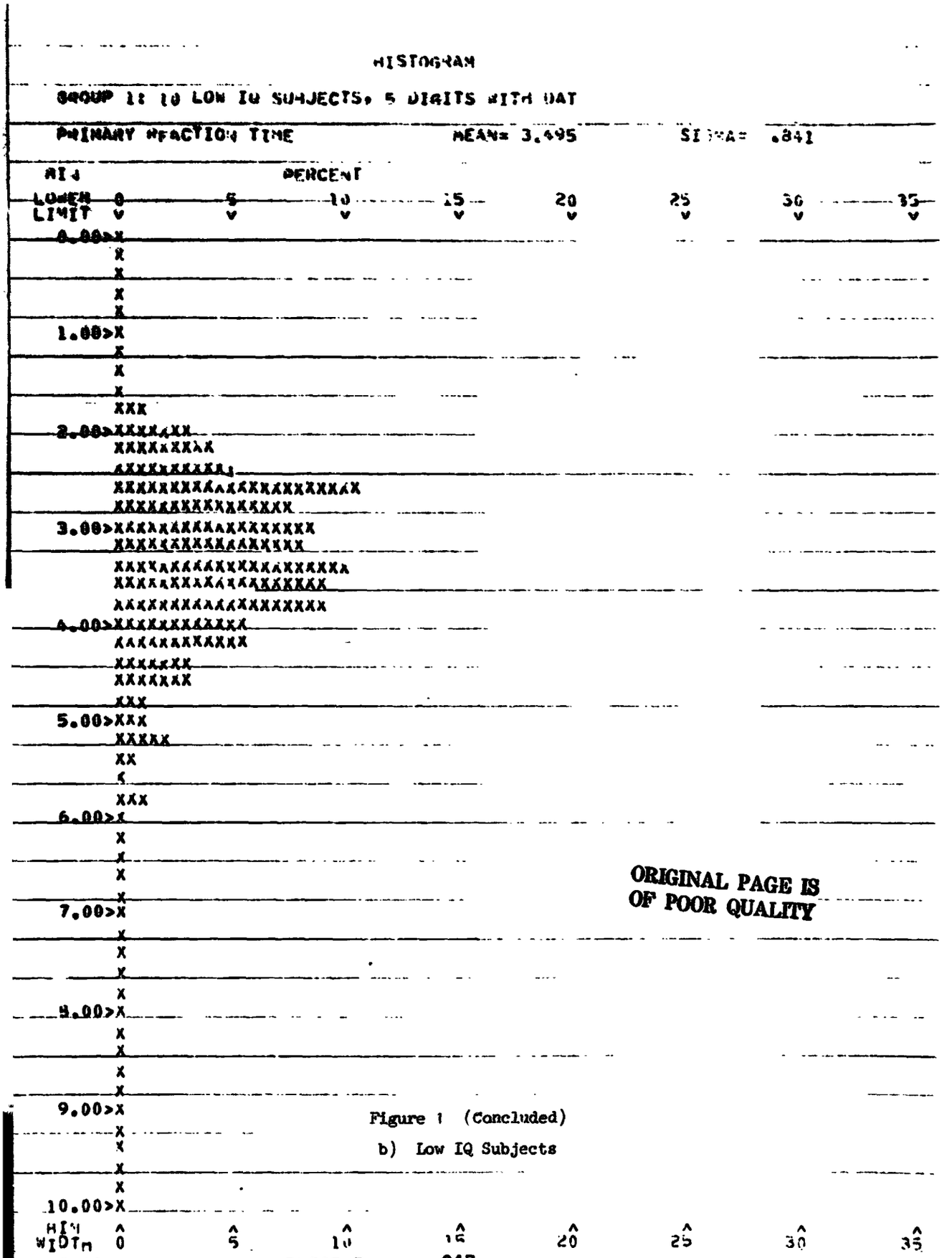

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Figure 1 (Concluded)

b) Low IQ Subjects

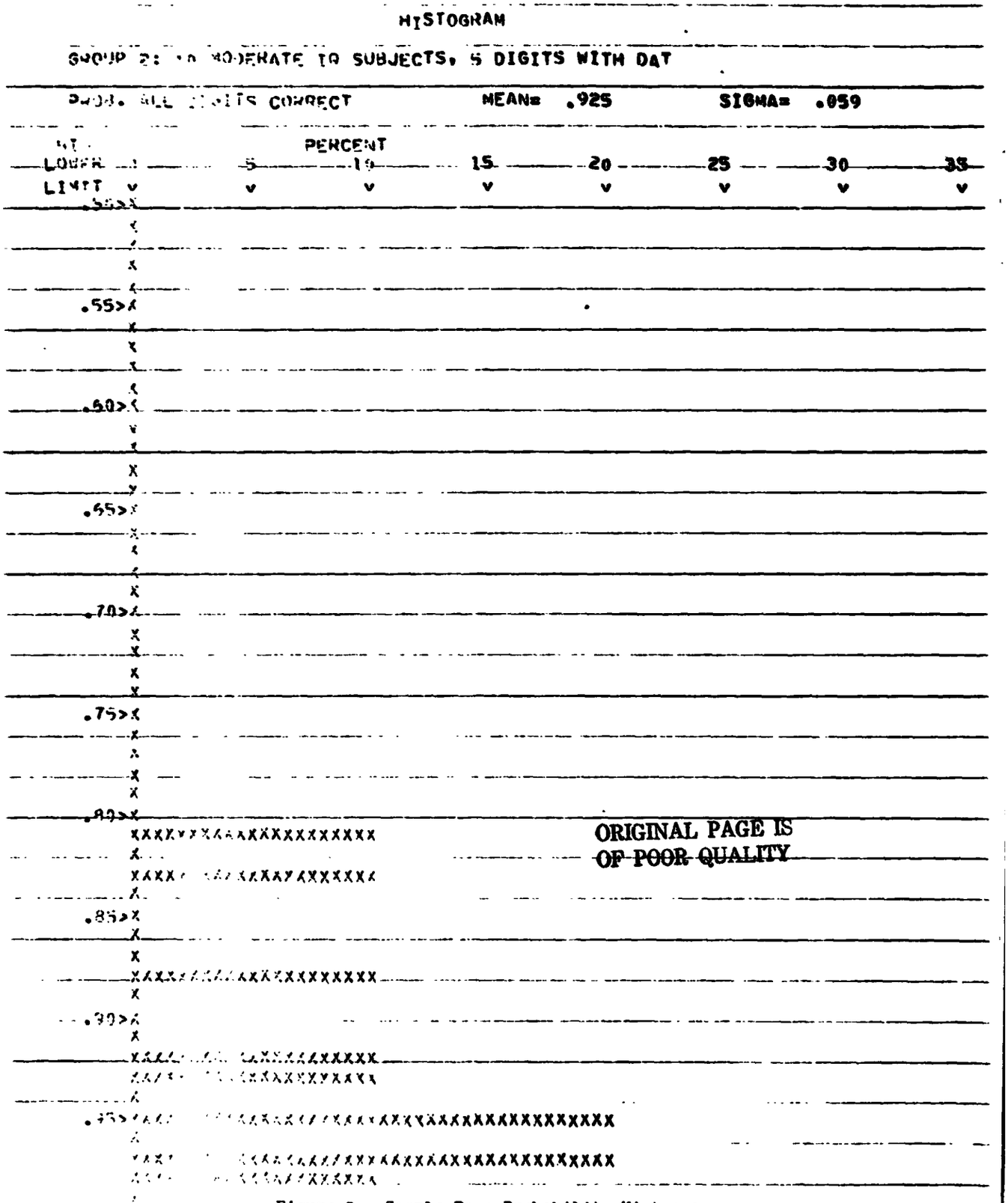

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Figure 2. Sample Pass Probability Histogram
a) Average IQ Subjects

HISTOGRAM

GROUP 1: 10 LOW IQ SUBJECTS, 5 DIGITS WITH DAT

PROB. ALL DIGITS CORRECT MEAN= .633 SIGMA= .060

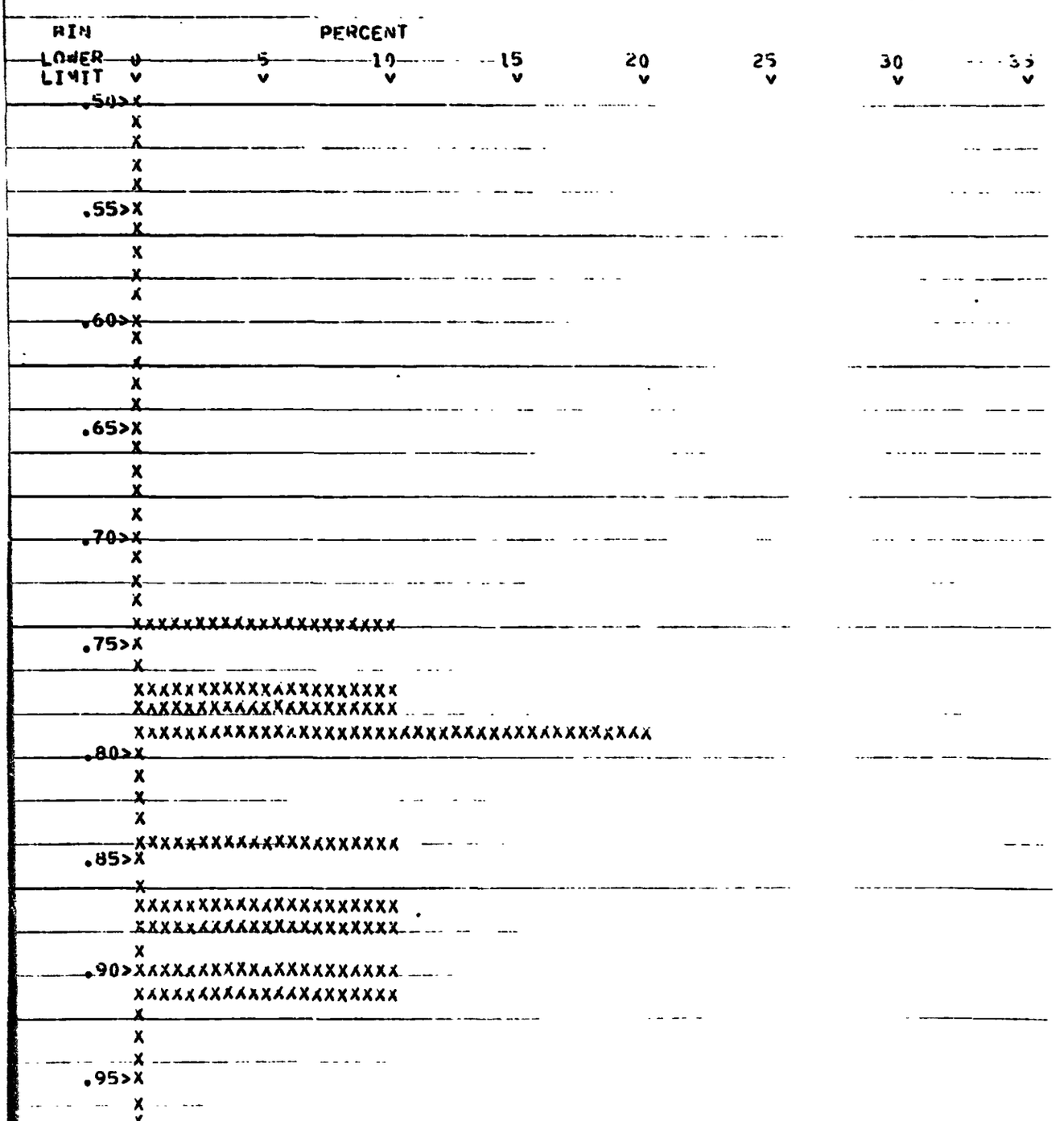

Figure 2 (Concluded)

b) Low IQ Subjects

TABLE 1

PERFORMANCE COMPARISON

QUALIFIER	COMPARED SUB-GROUPS	NUMBER OF SUBJECTS	MEAN PRIMARY RESPONSE TIME, T_{R_p}		PERCENTAGE PASSED		MEAN SECONDARY RESPONSE TIME, T_{R_s}	COMMENTS
			WITHOUT DAF	WITH DAF*	WITHOUT DAF	WITH DAF		
INTELLIGENCE	AVERAGE IQ	20	3.03	2.90	92	93	0.70	1. Average IQ S's faster on primary, by 0.3-0.6 sec on the average. 2. Average IQ S's have high pass percentage. 3. Difference in pass percentage with DAF is significant at 1%. 4. DAF increases differences in pass percentage.
	LOW IQ		3.55	3.50	85	83	0.76	
KEYBOARD SKILL	HIGHLY SKILLED	32	2.68	2.50	92	88	0.68	1. Skilled S's faster on primary, by 0.4-0.5 sec on the average. 2. T_{R_p} differences with DAF significant at 5%. 3. Skilled S's more homogeneous on primary. 4. DAF reduces differences in pass percentage.
	NON-SKILLED		3.09	2.97	88	87	0.72	
SEX	FEMALE	54	2.74	2.70	91	89	0.69	1. Female S's faster on primary, by 0.04-0.5 sec on the average.
	MALE		3.08	2.94	91	87	0.71	
DRINKING HABITS	NON-HEAVY DRINKERS	60	3.03	2.95	91	88	0.76	1. Non-heavy drinkers slightly faster on primary, by 0.15-0.15 sec on the average. 2. Non-heavy drinkers have slightly higher pass percentage. 3. Differences in T_{R_p} more apparent for faster response times. 4. Difference in pass percentages without DAF is significant at 1%.
	HEAVY DRINKERS		3.16	3.10	88	86	0.70	
AGE	YOUNG (<30)	56	3.04	2.98	90	86	0.69	1. Young S's slightly faster on primary, by 0.2 sec on the average. 2. Old have slightly better pass percentage.
	OLD (>40)		3.26	3.16	92	88	0.76	

*DAF effects include learning effects.

summation of the subjects with different mean times and fairly narrow distributions or if all subjects have the same reaction time characteristics. Therefore, we also examined each subject's mean and standard deviation of the primary reaction time with the DAT. These will be shown later in cumulative histograms. The differences between groups were subjected to the Kolmogorov-Smirnov test for statistical significance.*

Comparisons were also made on the basis of the pass percentage for each subject within the group. It should be recalled that the tests were conducted without any primary task time limits, and so the pass percentage is very nearly the probability of the subject's keying in the proper number. The pass percentage for each subject within a group was computed and a histogram was made for all the subjects within the group, see Fig. 2 for an example. Differences between the histograms were checked for statistical significance using the Kolmogorov-Smirnov test.

The results of the group comparisons are summarized in Table 1. The five comparisons have been arranged in order of the practical significance in group differences, the most significant listed first. In examining the data presented in Table 1 one must be careful about comparisons of the same subgroup with and without the DAT. Since the subjects were first tested without the DAT, the effects of the DAT are confounded with learning effects. This is obvious when one looks at the mean primary response times and notes that the times always decrease with the addition of the DAT. From this it appears that the learning effects on response time are stronger than the DAT effects, that is, the learning reduces the response time more than the DAT increases it.

In the first group comparison, we see that the average IQ subjects are considerably faster on the primary task than the low IQ subjects. The difference is about 0.5 to 0.6 sec. This is also indicated in Fig. 3 which is a cumulative histogram for the mean primary response times. In Fig. 3 we see a fairly constant time shift across all the subjects. The difference is not, however, statistically significant, at least at the 5% level, because of the relatively small number of subjects, i.e., 10 in each subgroup. Table 1 also shows a considerable difference in pass percentage, with the

*Siegel, Sidney, Nonparametric Statistics, McGraw-Hill, New York, 1956.

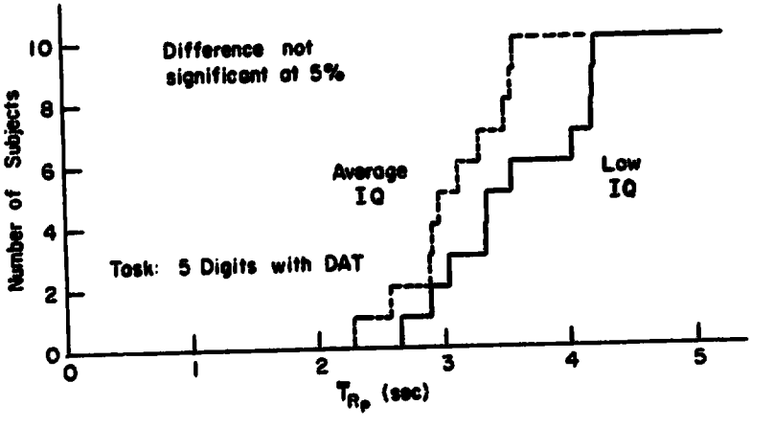

Figure 3. Group Comparison, Intelligence

average IQ subjects doing better. Note particularly that the difference is increased with the addition of the DAT (i.e., 92-85 < 93-85). In fact, with the DAT this difference in pass percentage becomes significant at the 1% level. Again, it is not certain whether this effect is due to the DAT or learning. However, it is interesting to note that going from the task without the DAT to that with the DAT, the average IQ subjects got better and the low IQ subjects got worse. This data trend could either be due to the average IQ subjects learning much more rapidly than the low IQ subjects, or because the low IQ subjects are much more adversely affected by the DAT than the average IQ subjects. In either event, it appears that intelligence has a very significant effect on performance, at least for the level of training employed here. If we look at only the data with the DAT we would conclude that the difference is significant for subjects who have had on the order of 75 practice trials.

In the second group comparison, the effects of keyboard skill are examined. The data shown in Table 1 indicate that skilled subjects are faster on the primary task by 0.4 to 0.5 sec. This large difference is statistically significant at the 5% level. Fig. 4 shows a fairly even shift in response time between the skilled and nonskilled subjects. It is interesting to note in Fig. 4 that the skilled subjects are a more homogenous group, that is, the cumulative histogram is more nearly a vertical line. On the other hand, some of the nonskilled subjects are also quite fast, but there is more variation within the group. On the basis of pass percentage, we see that there is a fairly small difference between the subgroups with the skilled being slightly better. Also note that the difference is diminished with the DAT. This might also be attributed to learning effects in that the nonskilled subjects may become as good as the skilled ones with sufficient practice. This theory seems to be supported by the pass percentage data but is not supported by the primary response time data. However, the difference in this case is only about 75 practice runs. We would conclude, therefore, that prior keyboard skill does have a significant effect at the training level of our subjects. Whether or not this difference would diminish or be eliminated with additional training is an unanswered question.

In the third group comparison we find that male-female differences are of marginal practical significances, the main difference being the female

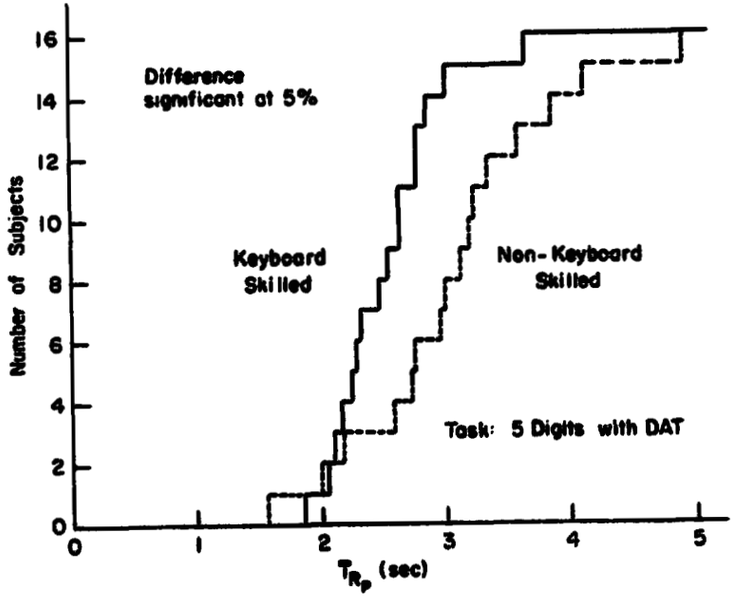

Figure 4. Group Comparison, Keyboard Skill

subjects are faster on the primary task by 1/4 to 1/3 of a second on the average. A more detailed view of this difference is shown in Fig. 5. Here we see no differences at the extremes, that is, for the fastest and slowest response times, but for the medium subjects the females are faster than the males.

The effects of drinking habits are seen in Table 1 to be quite small. The nonheavy drinkers are slightly faster on the primary task and have a slightly higher pass percentage. Fig. 6 shows that the difference in primary reaction time is not uniform but occurs only for the faster subjects. When we consider reaction times of more than 3 sec, Fig. 6 shows no difference at all between the heavy and nonheavy drinkers.

The results of the fifth group comparison were somewhat surprising. It showed a negligible effect of age. Young subjects were slightly faster on the primary task — on the order of 0.2 sec — but had a slightly lower pass percentage. Fig. 7 shows very similar distributions of primary reaction times.

There was some question as to whether this unexpected result was due to the fact that the old group wasn't old enough. Of the 28 "old" subjects only 9 were over 50 and 1 was over 60. To further explore the effects of age, we took each matched pair of subjects in the age comparison and subtracted their mean response times on the primary task. This was then plotted against the age of the older subject and is shown in Fig. 8. These data are very scattered and no trend with age is obvious. Clearly, within the test conditions of this experiment the effects of age are of no practical significance, at least up to roughly 60.

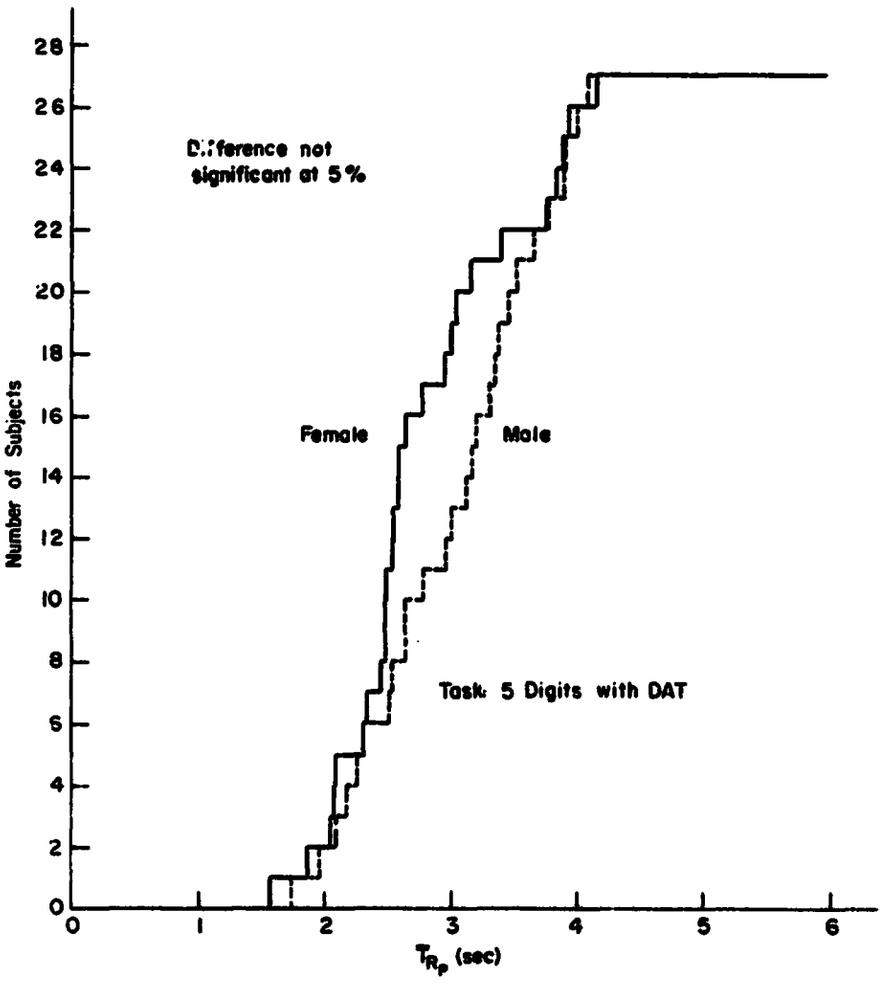

Figure 5. Group Comparison, Sex

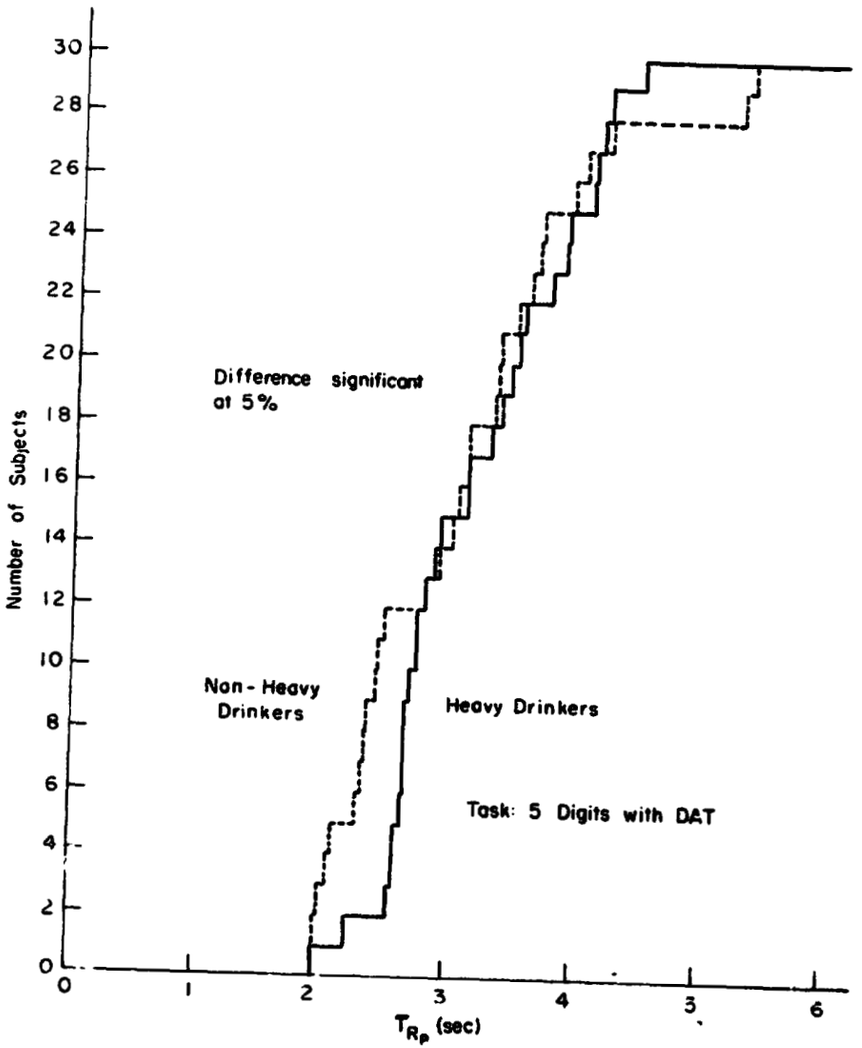

Figure 6. Group Comparison, Drinking Habits

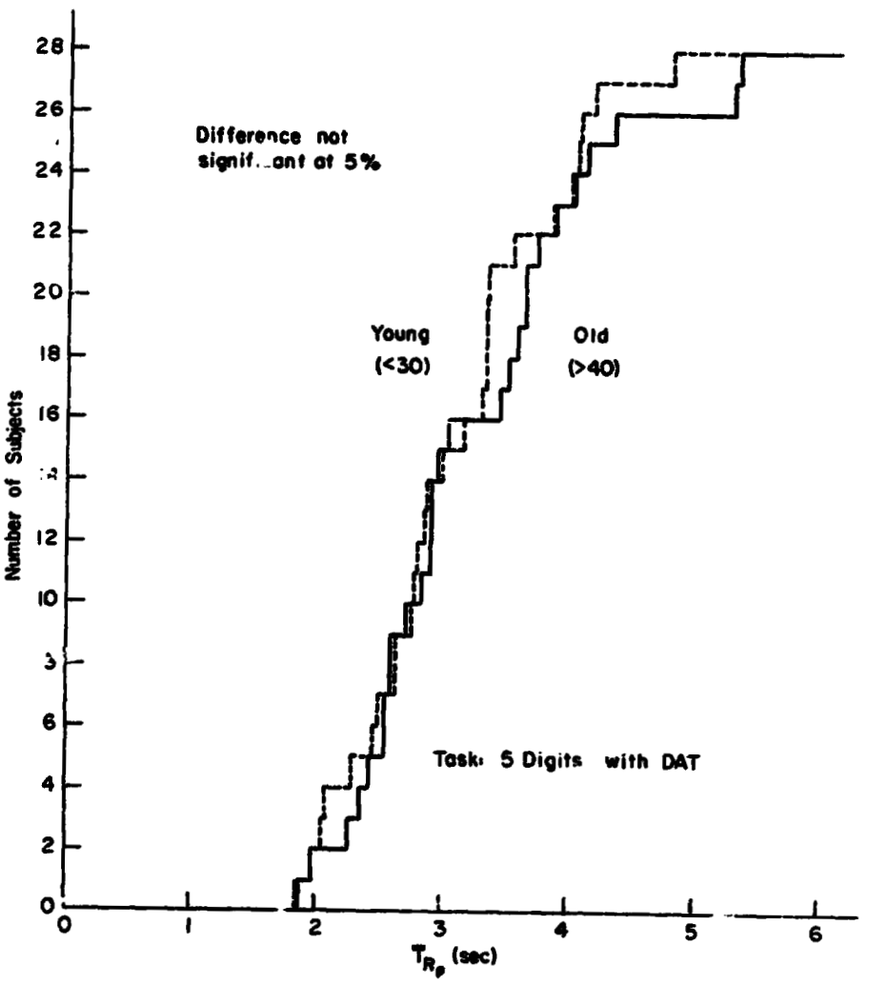

Figure 7. Group Comparison, Age

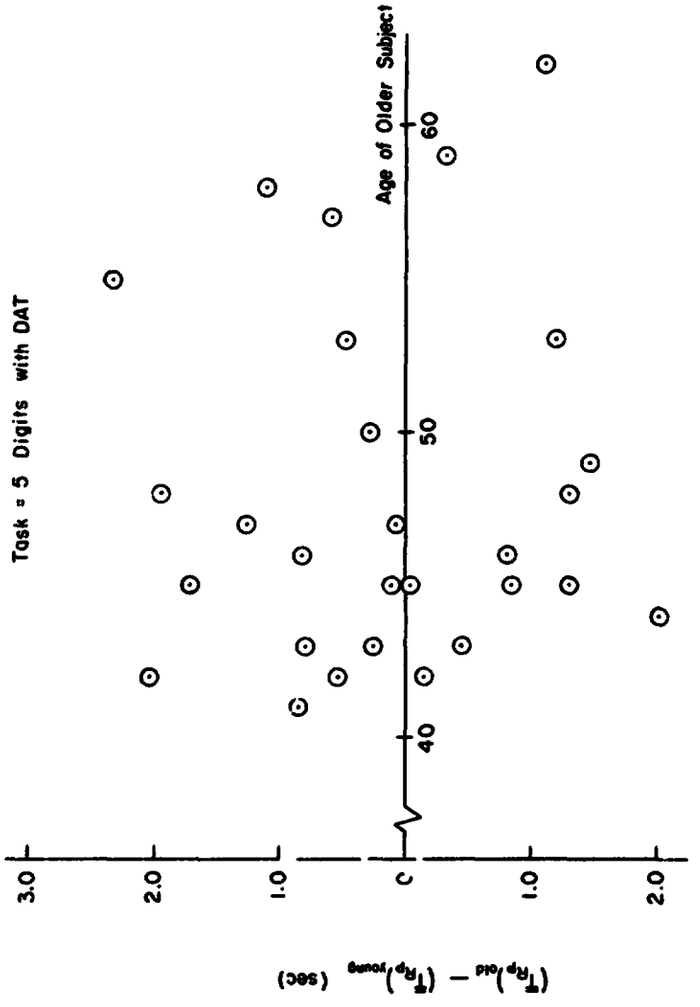

Figure 8. Reaction Time Differences for Old/Young Matched Pairs

EYE AND HEAD INTERACTION IN VISUAL SEARCH

*Peter Delp, Gordon Robinson, and John Ringenbach

ABSTRACT

A laboratory experiment provided quantitative data on transient responses of the eye and head to targets of unknown location and varying complexity. The objective was to provide correlative data for road test measurements of the visual search dynamics of vehicle drivers.

The location of the targets ranged from an initial straight forward fixation point to from 20 to 100 degrees to the right in horizontal plane only. Target complexity was varied from a four choice discrimination task to an eight choice task. A corneal-scleral boundary contrast technique was used to measure eye position relative to head, and the head position relative to the initial fixation point was measured by electro-mechanical means. Ten student subjects were employed.

The effect on the transients of alcohol was also measured.

The authors are with the Department of Industrial Engineering, University of Wisconsin, Madison, Wisconsin.