Subject were recruited as offices of the California Motor Vehicle Department and Human Resources Development. Each subject who was accepted was given a drinking-profile test (based on NDEE-HEU 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 1/3 trials on the task without the DAT. The first 1/3 trials were excluded from the subsequent data analysis. They were then briefed on the operation of the DAT and given another 1/3 trials on the task with the DAT. The first 1/3 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. 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 numbers. The problem is whether the group distribution is due to the
Figure 2: Sample Pass Probability Histogram

- **Average IQ Subjects**


**Figure 2 (Concluded)**

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b) Low IQ Subjects
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Table 1: Performance Correlation
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

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average IQ subjects doing better. Note particularly that the difference is increased with the addition of the DAT (i.e., 90-95 < 93-93). 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 3% 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, one of the nonskilled subjects is 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 affects 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 7% 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
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 fastest 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 8 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
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.

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