# Visual Acuity and Driving Record

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•THE INSTITUTE of Transportation and Traffic Engineering at UCLA has for a number of years been conducting research on human factors in transportation. Within this general area considerable activity has been directed toward studying the visual requirements of the driving task. The California Department of Motor Vehicles, because of its responsibility for selecting individuals who should be licensed to drive a motor vehicle, also has a strong interest in knowing the visual requirements of driving, so that a more valid and reliable vision-screening procedure might be used.

It is not surprising, then, to find the Institute and the Department cooperating in a joint research venture whose purpose is to determine whether relationships can be found between how well a person sees and how well he drives, as reflected in his driving record. The U. S. Public Health Service is supporting a three-year research program to study the relationship between vision test scores and driving record. A preliminary report (1) presents a detailed description of the study as well as of the background research leading to it. The purpose of the present paper is to outline the general nature of the research program and to present the results obtained thus far from preliminary data analyses.

## OVERALL RESEARCH PLAN

The general procedure followed in the study may be summarized in the following steps:

1. Solicit volunteers from among driver license applicants at Department of Motor Vehicles (DMV) field offices scattered throughout California.
2. Measure visual performance and obtain personal and driving information for these volunteer test-subjects. Also, obtain as much information as possible about "non-test-subjects," i.e., the applicants who refuse to be tested, as a check on the representativeness of the sample.
3. Forward the information obtained to DMV headquarters in Sacramento, where a search is made of each subject's three-year driving record.
4. Whenever possible, locate and examine the insurance record for each applicant tested, to provide a more complete picture of his driving record.
5. Code the accumulated information, place it on IBM punch cards and process the data by means of an IBM 7094 computer at UCLA.
6. Draw conclusions and suggest modifications in present California driver license vision-screening procedures, as warranted by the results.

Each of these steps requires some elaboration.

1. Subject Sample—The goal of the study is to test some 18,000 volunteer driver license applicants from throughout the State of California, in order to obtain as representative a sample of drivers as possible. The obtained sample is periodically compared with an authoritative description of the California driving population (5) as a check on possible sampling bias. There are 46 separate testing locations, and more than 14,000 drivers had been processed as of January 1965.
2. Field Testing—Each subject is given an interview in which detailed personal and driving history information is obtained. Following this, a series of vision tests is

Paper sponsored by Committee on Road User Characteristics.

administered, including tests for (a) static (or standard) visual acuity; (b) dynamic visual acuity (2, 3, 4), which refers to the ability to perceive an object when there is relative motion between the observer and the object; (c) field of vision; (d) acuity under low illumination; (e) glare recovery; (f) eyedness (which is similar to handedness); and (g) lateral phoria, which is concerned with the "aim" of the eyes, from cross-eyed to wall-eyed, with varying degrees in between. In addition, a record is made of each applicant who declines to take part in the study, for the comparative purposes mentioned.

3. Driving Record Compilation—All information obtained is recorded on specially constructed coding forms, which are then sent to DMV headquarters in Sacramento. The search for driving record information (which may take several months to complete) is initiated at this point.

4. Insurance Record Searching—One of the unique aspects of the study is the cooperation that the insurance industry has extended in permitting project personnel to evaluate insurance records for the people tested in the study. It is unfortunate that no complete record of all the accidents incurred by a driver can ever be available. However, by combining the information on file at DMV headquarters with that available from the insurance company, it is possible to obtain a much more complete picture of the driver's record than would be available from either source alone. As with the information obtained from the subject in the field office, all insurance information is held completely confidential, and cannot affect the subject's license or his relationship with his insurance company in any way.

5. Computer Analysis—Computer programs for the IBM 7094 have been developed, and are continually being modified and updated. An important consideration has been to make the programs as general and flexible as possible, to permit their use on data other than those accumulated in the present study. It is anticipated that these programs will be published at some future date, to make them available to others interested in the same general problem area.

6. Application of Research Results—Assuming the experimental results obtained are the consequence of properly conducted research, the University has met its primary research obligation. The more difficult task lies with operating agencies such as the Department of Motor Vehicles. Their task is to evaluate research findings in order to decide a course of action based not only on such findings, but on economic and time factors as well. In California, for example, if the results of the study were strongly to suggest the addition of 5 minutes of vision-testing in screening each applicant, this would necessitate hiring an additional 132 driver license examiners, an increase of approximately 38 percent over the present manpower requirements. If this figure sounds too high, remember that California issues 12,700 new or renewal licenses every working day. Thus, the implications of each decision regarding the procedure for granting driver licenses must be carefully studied before action is taken.

## DRIVING RECORD INFORMATION RETRIEVAL SYSTEM

Early in the design of the project it was decided that detailed information on accidents and violations was necessary to properly evaluate driving performance in relation to visual performance. For example, certain types of accidents (e.g., equipment failure, or being rear-ended while at a stop signal) obviously are unrelated to vision, and hence must be excluded from the analysis if possible relationships between driving and visual performance are to be uncovered. Thus it became necessary to have specially-trained coders to evaluate and classify each accident in terms of the circumstances surrounding it. To a reduced extent, the same caution had to be applied to evaluation of traffic citations.

Also, because of the volume and complexity of work involved in manually searching, retrieving and coding accident and violation data from the 40-million document driver record file in Sacramento, additional personnel had to be hired, and a detailed accounting system had to be devised to keep track of all work in progress. For example, interview forms for subjects with less than a three-year driving record in California at the time of their testing have to be placed in a "hold" file until such time as a three-year record has accumulated.

Each driver's file in Sacramento consists of his license application, any address changes or failure-to-appear notices, a card for each court conviction for a moving traffic violation, and a card for each accident reported. Culpable and non-culpable accidents are not differentiated in the file, and the coders make no attempt to do so. All documents in the driver record file are maintained for three years, except those for which the law requires a longer retention period.

California law does not require reporting to the State those accidents involving only property damage. Thus, this type of accident, even though important to the project, is not routinely reported by all local law enforcement agencies. The best source of information for such an accident is the driver report required under the state's financial responsibility reporting law. This law requires the driver to report every accident in which the damage to any one vehicle is in excess of $100; however, the report form used for this purpose does not provide detailed information as to the accident circumstances. Fortunately, the driver's insurance carrier and policy number are recorded, and this is useful in insurance record searching.

Since a driver's record file contains an index card indicating merely the occurrence of an accident, in order to learn the details of the accident, e.g., time of occurrence, weather conditions, road conditions, direction of impact, and other critical facts describing the accident circumstances, it is necessary to carry the search for driving record information a step further, i.e., to police investigation reports and/or insurance company records.

California Highway Patrol and other law enforcement agency accident reports are examined for details on accidents under investigation. In addition, through the cooperation of the insurance industry, claims files for subjects in the study are made available to trained project personnel for detailed evaluation.

Although all insurance carriers contacted have indicated willingness to cooperate in the project, for reasons of efficiency and economy files for only the 18 largest carriers in California are being searched. These 18 companies insure over one-half of the insured drivers in California. Results thus far indicate that this additional source of accident information has proved very valuable, since it has made possible the location of an additional 11 accidents for every 100 drivers in the study group, as well as providing detailed information not otherwise available on many other accidents.

Once all aspects of the driving record information search have been completed, the entire set of accumulated data is coded, checked, placed on IBM punch cards and transmitted to the University for data analysis.

Figure 1 shows how data are accumulated and processed for the subject who is tested; Figure 2 shows the comparable sequence for non-test subjects.

## RESULTS OF PRELIMINARY ANALYSES

Because of the complexity of the driving record information, there is a lag of several months between the time a driver is tested and the time his IBM cards are at UCLA ready for analysis. In addition, almost 20 percent of the subjects are placed in the hold file until such time as they have accumulated 3 years of California driving experience. It is for these reasons that preliminary data analyses had been conducted on a much smaller number than the more than 14,000 drivers tested.

To the present time, 2 brief analyses have been run. The first one, completed in early 1964, involved 2000 test-subjects and 2200 non-test subjects. In December 1964 similiar analyses on the first 5000 test-subjects were run off. Both analyses were concerned primarily with the relation of visual acuity (both static and dynamic) to driving record. Subsequent analyses will involve other measures of visual performance as well.

In summary, the results of these analyses may be stated as follows:

1. There is evidence suggesting a positive relationship between good dynamic visual acuity and good driving record. The results do not as yet provide unequivocal evidence of a similar relationship between static visual acuity and driving record.

2. There is evidence indicating that a significant difference in driving record exists between volunteer subjects and drivers who refused to participate in the study, the latter having a poorer record.

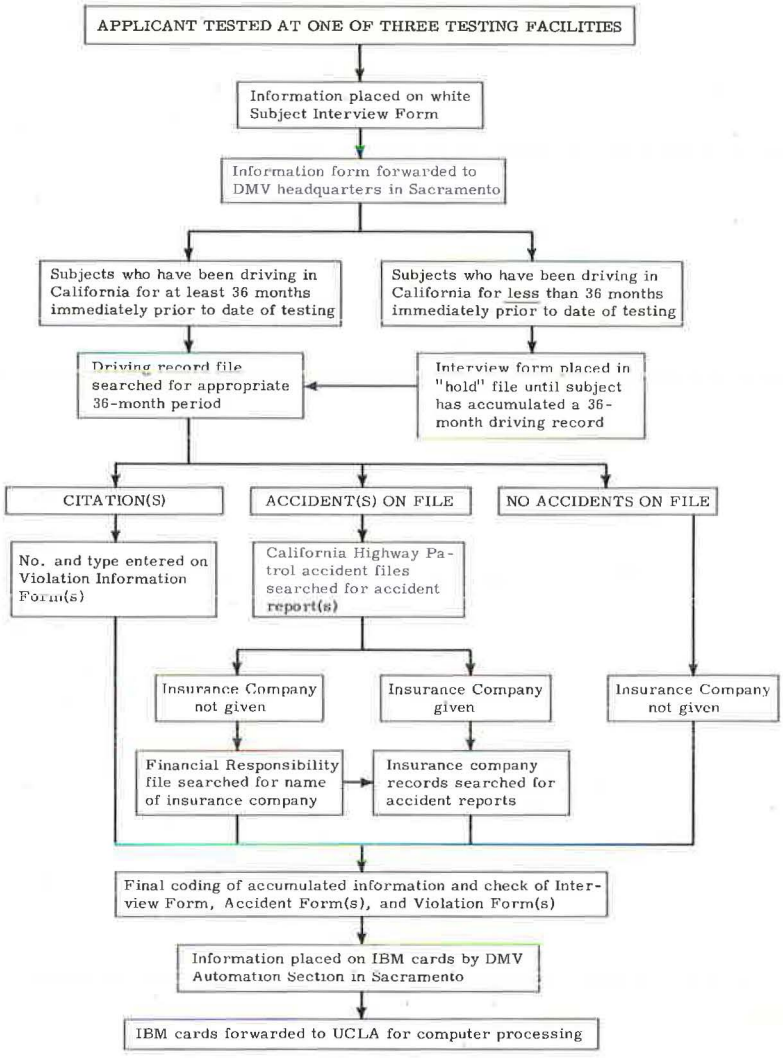


Figure 1. Flow chart of vision-test subject information.

3. The analyses show a definite relationship between performance on the dynamic visual acuity test and sex, age, and static acuity. Performance on the test is poorer for females than for males, becomes gradually poorer with increasing age, and is significantly correlated with static visual acuity. In connection with the last finding, the faster the speed of the target in the dynamic test, the lower the correlation of dynamic acuity performance with static acuity performance.

Each of these findings requires some further explanation. The reason for wishing to obtain information on 18,000 drivers is that such a large number will permit breaking down the sample into many subgroups on the basis of such factors as age, sex and annual mileage, all of which are known to be related to accidents and citations.

However, the relatively small number of subjects available for the preliminary analyses did not permit as fine a breakdown as will be possible with the total sample. For example, it was not possible to analyze separately only those people who drive less than 5000 miles per year as compared with only those who drive over 20,000 miles per year, since the bulk of drivers, who log between 5000 and 20,000 miles per year,

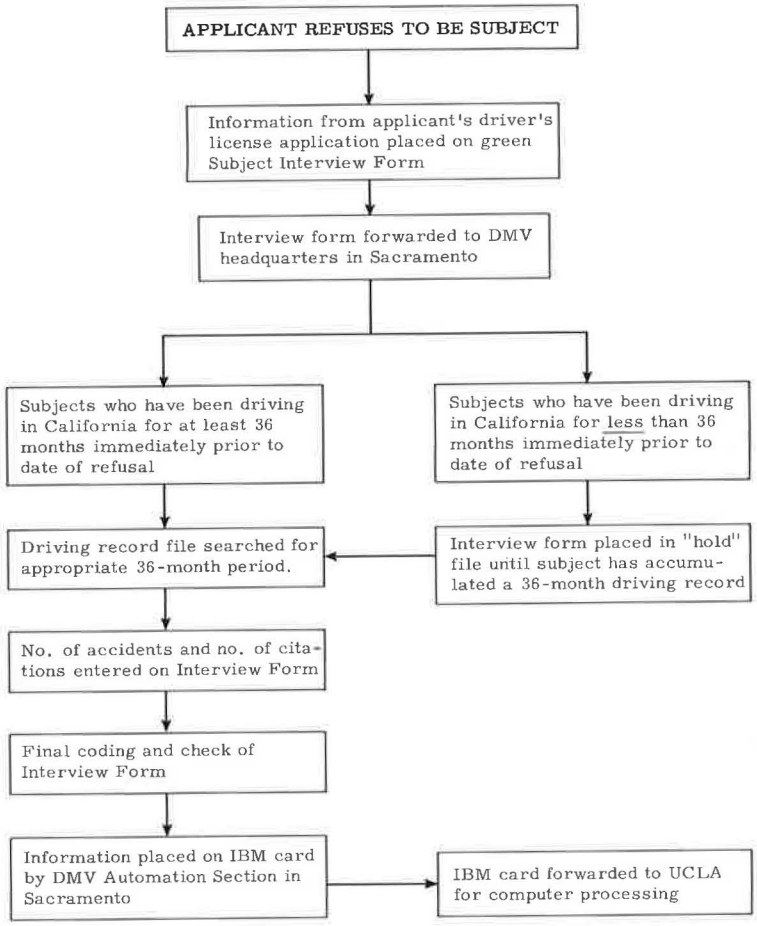


Figure 2. Flow chart of non-vision-test subject information.

would have been eliminated from the analysis. Instead, a median annual mileage was calculated for each of 6 age groups and for males and for females separately, and for each of the resulting 12 age-sex groups the drivers below the median were analyzed separately from those above the median. This provided at least a partial control over the effects of exposure on driving record, although not as much as will be possible later on, of course.

The same discussion applies to age groupings, where analysis of the total sample will permit the use of perhaps 11 age categories, instead of just 6, resulting in a "purer" measure of the relationship between vision and driving.

In view of these comments, it is encouraging that for a number of these 24 age-sex-exposure groupings, a significant chi-square relation was found between good dynamic acuity and both lack of accidents and lack of violations. While this significant relationship was not found for all age-sex-exposure groups, the very fact that any relationship at all showed up is encouraging, in view of the coarseness of the age and exposure controls referred to above. Obviously, however, it is too soon to draw any firm conclusions.

The fact that volunteer subjects appear to have better driving records than non-volunteers is not surprising. It is a small, but significant, difference, and is an important finding in that it serves to caution researchers against over-generalizing the results obtained from a volunteer sample. In the case of the present study, there is no reason to suspect that the "subjects" had significantly different visual characteristics

from the "non-subjects," and hence, generalization for the driving population as a whole is permissible. This would not be the case in a study of, say, driver attitude in relation to accident experience.

The major importance of finding that dynamic visual acuity is related to age and sex is that it suggests the possible need for differential licensing requirements for different age-sex categories in the event a dynamic test is ever incorporated into the licensing procedure.

In conclusion, it should be emphasized that the foregoing results are based on limited and preliminary analyses. The findings are merely indicative, and must await confirmation or rejection based on detailed analyses of the total sample of subjects. Nevertheless, regardless of whether the final analyses demonstrate any consistent, significant relationships between vision test scores and driving record, the study will have intrinsic value because for the first time a substantial amount of normative data will be available on a large number of drivers. These normative data will concern not only visual performance and driving record, but other factors as well, such as driving habits, driving experience, age, sex, occupation, smoking habits and many other items included in the interview but not mentioned here. The final report will contain many analyses of these other items, as well as suggestions for an almost unlimited number of additional analyses and cross-tabulations which are now possible for the first time, because of the advanced state of computer technology.

## REFERENCES

1. Burg, A. An Investigation of Some Relationships Between Dynamic Visual Acuity, Static Visual Acuity and Driving Record. UCLA Dept. of Engineering Rept. No. 64-18, April 1964.
2. Burg, A. Apparatus for Measurement of Dynamic Visual Acuity. Perceptual and Motor Skills, Vol. 20, pp. 231-234, 1965.
3. Burg, A. and Hulbert, S. F. Dynamic Visual Acuity as Related to Age, Sex, and Static Acuity. Journal of Applied Psychology, Vol. 45, pp. 111-116, 1961.
4. Hulbert, S. F., Burg, A., Knoll, H. A., and Mathewson, J. H. A Preliminary Study of Dynamic Visual Acuity and its Effects in Motorists' Vision. Journal of the American Optometric Association, Vol. 29, pp. 359-364, 1958.
5. The 1964 Driver Record Study. State of California, Department of Motor Vehicles, Sacramento, 1964.