Dr Raymond Dodge, chairman of the Division of Psychology, National Research Council, then presented a paper

THE HUMAN FACTOR IN HIGHWAY REGULATION AND SAFETY

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Problems of the maximum usefulness and the maximum safety of highways are of two main varieties One variety, of necessity the first and one most commonly considered, concerns the speed, direction, frequency, and weight of traffic and the reactions of the road. The other concerns the human factor, human perceptions and reactions, human attention, frailties and confusion The first variety of problems is physical The second is mental or psychological

Notwithstanding some exceedingly valuable special investigations, especially by Mr Eno and the Eno Foundation, as far as I am aware, no systematic exploration of the human factor in traffic has ever been undertaken For obvious reasons it is more difficult than the physical factor With increasing congestion of traffic it is certainly not less important Many otherwise useful schemes have suffered from a lack of insight into the mental processes which they involve At the beginning I wish to disclaim any special wisdom in the matter of the psychology of the highway It needs careful analysis and expert, thoroughgoing, experimental investigation It is my present purpose merely to emphasize the importance of studying the human factor and to illustrate my points by fragments of problems that have appeared to me in casual observation Mental problems of the highway seem to me to include the following classes·

1 The nature and placement of signs

2 The nature and time of signals

3 The visual limitations of drivers and pedestrians

4 Limitations of attention and sources of confusion of drivers and pedestrians

5 Minimum reaction times consistent with safety Reaction time and physical momentum bear direct relation to the permissible speeds

6. The development of standard tests and the correlation of tests with the various sorts of licenses to operate at different speeds and in different localities

7 Education for safety

If I may be permitted to call attention to some specific cases of inadequacies that have come to my attention, I can perhaps illustrate some of these points better by concrete instances than by generalities

1 Concerning Signs.

In front of the offices of the National Research Council there stands a sign with "SLO" on the top line and "SCHOOL" on the bottom line I do not know the theory under which that "SLO" was designed There is an obvious effort to dodge the adjective slow, and an equally obvious belief that words are read letter by letter, that a strange word of three letters is more quickly read and grasped than a familiar word of four letters With the grammatical issue I shall not quarrel, although *slow* as an abbreviation for "slow down" or "slow up" would be reasonably good English. The real objections to "SLO" come from the known facts in the psychology of reading It has been thoroughly demonstrated that adults do not read familiar words letter by letter but by familiar letter groups Any combination of letters may become familiar in time New combinations are read and understood relatively slowly When I first saw that strange sign it took me many times the effort and time to understand and interpret it that would have been sufficient for "slow" For the average stranger in Washington to whom that sign should especially appeal the familiar group of letters—slow—would be read and understood in a fraction of the time that was necessary for the interesting and ingenious configuration. This is a trival case. There is, however, a very real and important problem with respect to the ideal construction of a traffic sign. How many words will be read in the available time by a passing autoist? What should be the minimum size of letters? Where should signs be placed so that they will get the best attention of drivers or pedestrians? Uniformity in structure, placement, color, and content is a real desideratum There is already available a body of practical experience and a considerable body of scientific information which would only need to be adapted to highway use and experimentally verified

Another case that fell under my notice was the effort to increase visibility of the trolley posts on Connecticut Avenue by painting long white bands on them By an unfortunate accident these bands began several feet above the ground The optical usefulness of the white bands would have been enormously increased if they had run to the ground Then the position of the posts in lines of perspective would have much more clearly defined their spatial position More fundamentally, which is better, white posts or alternating bands of black and white?

Again I have noted the relative lack of visibility in the growing dusk of traffic policemen in their dark uniforms with dark gloves. The

addition of a diagonal white sash and light gloves would enormously increase their usefulness to pedestrians and their visibility to drivers

2. The Nature and Time of Signals.

As far as I can learn Washington has at least tentatively adopted hand and arm signals considerably ahead of the country at large It is, however, conspicuous that these signals have no definite time relation to the movements they indicate They are sometimes short and sometimes long, sometimes early and sometimes late. It seems particularly unfortunate that at a time when both hands of the driver might be needed for the operation of his steering device and emergency brake he is supposed to be using one of those hands for signaling a stop Some one of these processes is likely to be poorly executed The continuous indication of a driver's intentions beginning at least five seconds before a movement is executed and continuing until a movement is completed would be a great advantage It is mechanically entirely possible without interrupting the driver's control of the machine, if we settle the principle Similar indications by pedestrains, at least in crowded places, would be a great help to the drivers and should be enforceable It is often quite impossible for a driver to determine when a pedestrian is going to start a movement across the street, when he is going to retreat, or what direction he is going to take next. A simple scheme for the most desirable time of onset and the duration of signals can be worked out by any psychologist who will familiarize himself with the traffic situation, and who knows the limitations of attention and reaction time.

3 Visual Limitations

Perhaps the most obvious psychological service would be rendered in connection with the limitations of attention and the extent of clear vision In the present regulations of traffic the active concern of both driver and pedestrian never covers less than forty-five degrees of visual angle and may reach an angle of two hundred degrees and over The upper range is humanly impossible without moving the head from side to side. This always involves the interruption of vision in some part of the field of active concern One of the greatest dangers in crossing the street comes from vehicles that suddenly emerge unseen and unheralded from a side street Means for decreasing the visual angle of active concern should be carefully scrutinized and adopted wherever possible The prohibition of all left-hand turns is an expedient for which a splendid brief might be prepared Another brief might be prepared for the use of all parallel streets as

one-way traffic streets. Safety, maximum speed, maximum parking facilities, and saving of time with consequent relief of congestion and the convenience of foot traffic are all involved in one-way streets. Similar advantages are obtained by dividing wide streets by zones of safety wherever practicable

On the grounds of the visual angle of active concern there is a slight but real difference between different sides of the street for pedestrians It can be demonstrated that the left-hand sidewalk is safer It is well-known that the left-hand side of the street should be used by pedestrians when there is no sidewalk.

As a matter of safety there are grave doubts as to whether the present regulations that limit pedestrians to a narrow street crossing at exact intersections of streets is the best practicable solution It may be more convenient for drivers but the exact intersection of streets is certainly most dangerous for pedestrians Behind waiting cars is safer than in front of them Twenty feet from a cross street would diminish the probability of being surprised by turning cars

4 Sources of Confusion

Much has been done to diminish the sources of confusion, such as the introduction of signals and the establishment of zones or islands of safety where pedestrians can take their problems in smaller doses But, if I am correctly informed, any systematic analysis of confusion of pedestrians or drivers has yet to be made It would involve the practical limits of attention and the facts of human variability The sudden appearance of an unheralded vehicle coming around the corner, the convergence of vehicles on the pedestrian and even the blatant automobile horns themselves are worth considering as sources of confusion In this connection one may note again the advantages that would be derived from one-way traffic Confusion would be diminished by uniformity of traffic rules and signals, by training in time and space estimation, by better lighting of cars, and a better system of street lighting Most street lighting involves decrease of the visual acuity by peripheral glare.

5 Minimum Reaction Times

Aside from the purely mechanical conditions of stopping and turning the next most important factor in safety is the reaction time or personal equation, the time that elapses before the driver or pedestrian can start a movement that is required by a sudden emergency Slow and uncertain or wavering reactions are undoubtedly the occasion of many accidents Long reaction time is partly due to natural ten-

dencies of drivers and pedestrians—the so-called personal equation It is also due in part to lack of practice and training in appropriate reactions Both of these factors could be made matters of test

6 Standardized Tests

An even more conspicuously opportune field for psychological cooperation in solving the problems of safety and efficiency on the highway is the matter of constructing and evaluating a series of standardized tests for drivers It is possible that there ought to be tests for pedestrians as well, with distinguishing marks for incompetents It would be some help if the drivers could know that the man trying to cross the street was partially paralyzed, was partially blind or deaf, had a wooden leg, or some other disability which made it difficult to take care of what he had left As it is now youth and old age are the only clearly marked incompetents

It is notorious that tests of drivers in one community are entirely different from tests in other communities Licenses from different localities are quite incomparable in value Standard tests would be a real help But standardization of tests is not the only service that can be rendered It is entirely thinkable that tests should vary for the sorts of tasks which the drivers are called upon to perform That is to say, tests for drivers of light pleasure vehicles might conceivably be very different from tests for drivers of fast ambulances, or fire appliances, and they in turn might be quite different from tests for drivers of heavy motor trucks High-powered fast machines obviously should not be entrusted to poor or relatively untrained drivers A specific form of test for various types of machines is good common sense and good science. In addition to tests for mechanical expertness it is probable that tests for drivers of motor vehicles should be supplemented by tests of knowledge of standardized traffic regulations and automobile limitations, and possibly by some check on moral tendencies and regard for common interests. The preparation and standardization of a series of tests for drivers would be a task of no small magnitude and of conspicuous importance Forfeiting a license for misconduct on the road should be a national affair, not a merely local one. Driving after license is withdrawn should be a serious offense

7 Education for Safety

In addition to all of these possible services of psychology in the regulation of the highway there is undoubtedly need of the service of expert educationists The pedestrian must be trained as well as

the driver of motor vehicles and the proper place for that training is in the school It seems reasonable to suppose that one of the important school functions in fitting the child for his environment is the ability to take care of himself on the highway. This task obviously can be undertaken only when the regulation of the highways has reached a point where it is uniform in all the states and uniformity should only be aimed at when we are sure that from the standpoint of space and time as well as from the standpoint of the human mind the proposed regulations have been thoroughly scrutinized and revised Newspaper and movie campaigns by cartoons, advice, and stories should be continuous, not limited to one week a year

STATEMENTS FROM REPRESENTATIVES OF CONSTITUENT ORGANIZATIONS

Prof W. A Slater, representing the U. S Bureau of Standards: The Bureau of Standards is anxious to be of service to the Advisory Board on Highway Research and to the work of building adequate highways. It may be of interest to mention some of the current and completed work which has to do with the subjects under discussion today The first, which needs only to be mentioned because you will hear more of it from Mr James this evening, is the subject of automotive engineering

An experimental investigation of power losses in automobile tires is being made It was found for example, that more mechanical energy was absorbed in fibre tires than in cord tires Technical Paper No. 213, of the Bureau of Standards, gives some results of the investigation. Endurance tests of tires are now in progress, day and night, in which comparative data for tires of different types are being obtained Specifications for automobile tires, both pneumatic and solid, have been prepared at the Bureau of Standards These specifications have been adopted by the Federal Specifications Board for the purchase of government materials and have been published as Circular No 115 of the Bureau of Standards

The subject of bituminous coatings suitable for retaining-walls, bridges, etc , has received some study and the Bureau of Standards has on hand unpublished data which should have value in the selection of a coating which requires sufficient elasticity to span cracks of pre-determined width and retain sufficient solidity so as not to run during warm weather

Soil pressures have been studied by the Bureau of Standards and a report was made which was published in the Proceedings of the