

M E D I C A L D E F I C I E N C I E S

A N D

T R A F F I C A C C I D E N T S

A review of the literature and a programme for research  
( Summary )

1965

Stichting Wetenschappelijk Onderzoek Verkeersveiligheid

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Instituute for Road Safety Research (SWOV)

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## 1. INTRODUCTION

In 1964 a working party was established by the Dutch Government (Public Health Department) to study "Medical Deficiencies in the Prevention of Traffic accidents". The aims of the working party were formulated in terms of study of the literature so as to indicate what problems in this field need to be investigated and in what order of priority. Study of the literature was directed at temporary and permanent medico-psychological disorders, and medical disorders in road users that can affect road safety:

- 1) Visual deficiencies
- 2) Cardiovascular diseases
- 3) Alcoholic intoxication
- 4) Fatigue
- 5) Epilepsy
- 6) Psychiatric disorders
- 7) Diabetes mellitus and hypoglycaemias
- 8) Carbon monoxide poisoning
- 9) Menstrual cycle

Almost 400 publications were reviewed in order to obtain information on:

- a) Occurrence of these deficiencies in the (Dutch) population as a whole and among road users in particular.
- b) Occurrence of these deficiencies in accident statistics.
- c) The heightened probability of having an accident as a function of the presence of one of these deficiencies.
- d) Special circumstances under which the deficiencies can mean extra danger.
- e) The existence of possible negative side effects of treatment (e.g. administering medicines) to combat a medical disorder.

## 2. METHOD

As criteria for fixing priorities for research were stated:

### 2.1. Possibility of research

Whether research is possible depends on the availability of:

- a) An unambiguous definition of the factor.
- b) An empirical specification or quantification of the factor.

And also on:

- c) Occurrence, independent of driving or other road use.

The study of a disorder the occurrence of which is influenced by driving etc. requires an independent definition of the traffic situation; for instance, in terms of the stress imposed on road users.)

### 2.2. Relevance of the research for road safety

- a) Extent of these medical deficiencies in the total road user population.
- b) Temporary or lasting character of a medical disorder.
- c) Correlation between medical disorders and the incidence of traffic accidents, as a result of empirical investigations or as a result of theoretical expectations.

### 2.3. Expected "pay-off" of the research

- a) Measures that can be taken on the basis of results of the research and the expected returns from these.  
(Measures to facilitate driving, for instance, will give higher returns than measures aimed at changing attitudes of road users).
- b) Advance of general knowledge benefiting the programmes of other investigations on road safety.  
(E.g. in the absence of empirically verified behaviour criteria for "safe driving", research into this topic deserves a higher priority than an investigation into, for instance, personality patterns and "driving attitude".)

2.4. Chance of success of the research

Availability and or obtainability of the requisite data  
(completeness, reliability, effort needed, cost etc).

### 3. RESULTS

#### 3.1. General findings

3.1.1. Many publications lay a heavy responsibility on the road user for the occurrence of traffic accidents. This is more often than not an incorrect and misleading view:

As regards influence on overall road safety, chance factors and circumstances "outside" the road user are found to be of the first order, and medical disorders and psychological deficiencies "within" the road user to be of the second order. (Drösler, 1965; Goldstein, 1961; Haight, 1964; Kerr, 1964 (1957)).

Even if the existence of accident-prone drivers were to be proved, application by selection of this group makes no real contribution to road safety:

Most traffic accidents are caused by road users with an "average" accident history and not by a small group of road users with a relatively large number of accidents behind them (Coppin et al., 1964). Where the contrary appears to be the case, the results of the investigations of differences (in medical and psychological characteristics) between these two groups are frequently not in agreement.

There is agreement, however, in the differences between these groups with regard to the number of kilometres travelled, the circumstances under which those involved drive and the risks inherent in this. There is, therefore, no basis for the desire to show, by reference to medical and psychological characteristics, that road users who in the past have been involved relatively frequently in traffic accidents are accident-prone.

3.1.2. Limitations and characteristics relating to (safe) driving which every road user possesses to a greater or lesser degree, are of more importance for road safety than are the abnormalities of a limited group of road users.

3.1.3. Behaviour in traffic is influenced not only by the limits of human ability to assimilate information and take decisions, but also by the opportunities for, and limitations on, movement

that one expects on the basis of past experience and/or on-the-spot observations, i.e. by experience as a road user on the one hand, and by presence of adequate and relevant information on the other. Human factors, such as fatigue, illnesses and also personality traits, rank third in order of priority.

Up to now, for instance, one-eyed persons, the near-deaf, people who are slow to react, have poor vision or other sensory limitations have not proved to be more dangerous than comparable groups not so affected. It appears that these limitations can be compensated for when driving.

A condition for this may however be the acquisition of sufficient driving experience: experienced older drivers are not involved in traffic accidents more often per total distance driven than experienced younger drivers. Unexperienced older drivers, on the other hand, are more unsafe than inexperienced young drivers (whose reactions are quicker) (SWOV, 1966)

### 3.2. Methodological aspects

3.2.1. The fact that little is as yet known about the relevance of research into human deficiencies for road safety has to be attributed not only to the methodical shortcomings of the research already done in this field, but also to the characteristics of "accident rate" as a characteristic of road users.

3.2.2. In using accident rate as a characteristic of road users, allowance must be made for change effects and risks regarding time and place.

3.2.3. The utility of the traffic accident criterion as a characteristic of road users is determined by the possibility of checking exposure to the well-known circumstances in traffic. A strict check on this, however, is generally not possible in practice. Even with a check on exposure and with carefully registered accident records, the reliability coefficients obtainable for the accident criterion are extremely low, especially for short periods of observation (Van Naerssen, 1962; Häkkinen, 1958; Coppin et al., 1964.). If the criterion is

unreliable, attempts to predict it, either on the basis of the accident history or from other (e.g. medical and psychological) predictors, will achieve little or no success (cf. Drösler, 1965 for a quantitative illustration).

3.2.4. The chance of finding correlation is reduced even further by the fact that people with extreme medical-psychological deficiencies are not allowed to drive (licence procedure).

3.2.5. The methodological aspects mentioned and the nature of the problem of traffic safety (traffic accidents as a multi-conditional result of traffic behaviour) call for a study on methods in use in the behavioural sciences in two ways:

- a) Accident analysis
- b) Behavioural analysis.

3.2.6. In the accident analysis the following guidelines may be of some use:

- a) Research over long periods of observation of accident frequency. The reliability of the accident rate as a criterion increases with the length of observation time. (It does so according to the Spearman-Brown formula for the effect on the reliability of extending the length of a test. (cf. Van Naerssen, 1962).
- b) Study of several factors simultaneously, with the aid of multivariate statistical techniques.
- c) Increasing the homogeneity of test groups, e.g. by differentiating according to age, sex, type of traffic etc., whereby irrelevant variation between subjects can be eliminated.
- d) Increasing the homogeneity of the criterion. In particular by differentiation according to type of accident, whereby criterion contamination can be eliminated. If the research is restricted to single-vehicle accidents, the (interfering) effect of the presence of other road users (and the resulting possibility of interaction effects) is then excluded.

3.2.7. In the experimental study of the effects of human factors on road safety, the accident criterion cannot be used. It is therefore necessary to develop alternative behavioural



criteria. Up till now these criteria have been stated more or less on an ad hoc basis. A more appropriate way may be to base these on a comparison of the behaviour of drivers with well-known accident probability characteristics (e.g. age, driving experience, alcohol concentration in the blood).

### 3.3. Reducing the seriousness of the consequences of accidents.

Even if maximum efforts are made to prevent them, road accidents will still occur. Measures to reduce the seriousness of accidents therefore still remain necessary, e.g.:

- a) The designing of vehicles and roads which limit the seriousness of injuries in the event of collisions.
- b) Medical research on the diagnosis and treatment of accident injuries.
- c) Efficient transport of victims to hospitals.

### 3.4. The utility of selection of drivers on accident criteria.

The utility of selection and examination procedures can be determined according to:

- a) Selection ratio (the percentage of candidates normally rejected).
- b) The validity of the predictor, or set of predictors (including the reliability of the criterion).
- c) The percentage of suitable persons in the population in the first instance.
- d) Socio-economic (cost) factors (cost of unjustified rejection or acceptance; cost of conducting selection in terms of material and staff).

If d) is given, the utility of selection increases as a) becomes more favourable, b) becomes larger and c) becomes smaller. (If almost everyone in the population in the first instance is suitable, there is little point in selection.)

With regard to selection based on the criterion of (expected) accident frequency as a personal characteristic, there is at present:

- a) A low predictor validity (partly owing to the unreliability of the criterion).

b) An unfavourable selection ratio (the right to drive is considered universal).

With things as they are there will be very little point in selecting and examining drivers on the basis of accident frequency by the means at present available. This is illustrated on a quantitative basis by Drösler (1965).

Selection on the basis of road accidents expected in the future with the aid of medical and psychological predictors, with validity coefficients applicable at present, brings about no improvement worth mentioning on selection by using past accidents as a predictor. (The maximum validity attainable is determined by the square root of the reliability coefficient. Since the reliability of the criterion is low, the validity of the predictor is also low.)

In view of the socio-economic returns, general selection (examination) of drivers based on the accident frequency expected in the future and using the means at present available cannot be considered useful. This implies:

- a) Research to find valid predictors for the selection and examination of road users.
- b) Development of behaviour criteria for selection and examination of road users, relating also to training and traffic ergonomics.

### 3.5. Assessing the literature on Priority criteria.

Of all the factors dealt with in the report there is no reliable and accurate information available for the Netherlands concerning:

- a) The extent of abnormalities in the total population or among groups of road users.
- b) The number and type of road accidents in which these deficiencies have played a role.<sup>11</sup>
- c) The correlation between these deficiencies and the occurrence or non-occurrence of road accidents.

Therefore a need for stating priorities for research is obvious. These priorities for research will be fixed by eliminating subjects by successive stages, according to the "possibility", "relevance" and "returns" of the research as stated sub. 2.

### 3.5.1. Possibility of research

a) A prerequisite is that the factors to be studied can be defined unambiguously and clearly, or can be recorded in quantitative terms.

The factors "epilepsy", "psychopathology, neuroses and psychoses", and "fatigue" do not satisfy this criterion. They will only become eligible after basic research (analysis and empirical specification of the concept) has been done.

The factors "cardiovascular diseases", "diabetes mellitus" and "hypoglycaemias" also require a clearer and a more unambiguous quantitative definition before a purposive study within the traffic context can be made. A clear definition of these factors which is suitable for the study, however, seems less complicated than in the case of "epilepsy" and "psychopathology neuroses and psychoses".

b) The occurrence of the factors "cardiovascular disease", "fatigue", "epilepsy", "hypoglycaemias" and "carbon monoxide" is partly determined by participation in traffic.

The success of research into these factors (which have a joint effect, i.e. influence on the level of alertness) is dependent upon the existence of a relevant definition of the stress due to traffic situations. This required long-term basic research. The factor "carbon monoxide" is an exception, for in this case definition of the traffic situation seems fairly simple (CO content of environment).

The factors offering prospects for study within the traffic context, not necessitating long-term basic research are "visual deficiencies", "consumption of alcohol", "carbon monoxide" and "menstruation".

### 3.5.2. Relevance of the research

Relevance of the research can be determined according to:

- a) The correlation to road accidents (empirical and theoretical).
- b) Measures that can be taken on the basis of the results of research.
- c) Contribution towards other research possibly even outside the field of road safety.

A correlation to road accidents has been empirically demonstrated in the case of:

- visual deficiencies, for dynamic visual acuity - (Burg and Coppin, 1965; Kallina, 1964)

- consumption of alcohol - (Borkenstein, 1964; McCarrol and Haddon, 1963; Lucas et al., 1955; Vamosi, 1960; Holcomb, 1938).

According to the literature, a possible correlation to road accidents could be assumed for:

- menstruation - (Hauptman, 1934; Mayer, 1958; Dalton, 1960; Lena et al., 1963).

- fatigue - (Crawford, 1961).

- cardiovascular diseases - (Thorndike, 1951; Hoffmann, 1963; Walbeehm, 1960; Levy et al., 1963; Bellanger, 1964; Norman, 1960; Berggrath and Valentin, 1960; Brandaleone, 1960; Berg and Melkind, 1962).

The influence of driving (stress) on the occurrence of cardiovascular diseases, however, seems to be greater than the influence of cardiovascular diseases on road safety. Consequently, in this case prevention from driving might be more in the interest of the driver than of road safety.

There seems to be no connection with:

- static visual acuity -

Despite numerous attempts, no substantial link between static vision and traffic accidents has yet been established.

Although observation in traffic is dynamic in nature, good static vision may be a necessary, though not sufficient condition for good dynamic vision. Moreover when traffic situations are created limitations in vision are sometimes taken into account, i.e. colour and brightness of traffic lights so as to allow for defects in the colour vision of drivers.

- carbon monoxide - (see also 3.5.)

Critical "collapse" values for the CO content in the blood of road users do not seem to be attained in modern traffic.

However, research into the chemical environment of traffic (CO, SO<sub>2</sub>, N<sub>2</sub>O<sub>4</sub>, carcinogens) may lead to general health measures (inspection of vehicles, particularly diesels, for combustion of exhaust gases).

- diabetes mellitus - (see also 3.5.1.)

If a hypoglycaemic condition occurs it can be corrected by a simple measure (administering glucose)

As regards the possibility and relevance of the study, the highest priority can be attributed to the factors:

"consumption of alcohol" and "menstruation".

3.5.3. Measures and return of the study

- vision -

Research into the part played by dynamic visual acuity and more generally the assimilation of information in dynamic situations is important, especially for traffic ergonomics, also for instruction and possibly the selection of drivers.

- consumption of alcohol -

Study of characteristics of consumers of alcohol who drive is of importance for: the selection of drivers, propaganda, traffic supervision, etc. It may even be of importance to public transport. Study of the correlation between alcohol concentration in the blood and road accidents provides a clear criterion for legal counter-measures.

- menstruation -

Returns of the study of the correlation between road accidents and menstruation are relatively small (measures limited to spreading information). This study therefore merits a relatively low priority.

3.5.4. As regards the possibility, relevance and expected returns of the research, priorities can be given to research on "alcohol" and "visual perception" in relation to traffic safety.

### 3.6. Formulating a research Programme

#### A. Accident analysis

3.6.1. Carrying out an analysis of the blood of the victims of (single-vehicle) traffic accidents resulting in hospitalization, to determine:

- a) Alcohol concentration in the blood
- b) Sugar content in the blood
- c) Carbon monoxide content.

3.6.2. Carrying out a post mortem on every person killed in a (single-vehicle) road accident. To determine the values specified under 3.6.1. and also:

- d) Organic brain injury
- e) Cardiovascular disease ¶
- f) Condition of endometrium.

Guidelines need to be established for recording the points specified. Post mortems on victims of road fatalities and blood tests on injured road victims will provide information on the relative part played by the factors mentioned in the occurrence of serious road accidents. On the basis of this information a decision can be taken as to whether more extensive study of the correlation with traffic accidents is worthwhile. With regard to the study of the correlation between alcohol consumption and traffic accidents, the decision to do this could already be taken on the basis of the literature. Only if this correlation is known can the efficacy of measures, such as selection and examination of drivers, be determined. If this information is not available, the number of people unjustifiably rejected (or accepted) cannot be determined, so selection and examination of drivers would be based on acceptance of the fact that an unlimited number of candidates would be unjustifiably rejected (or accepted).

3.6.3. Roadside checks on drivers to determine alcohol concentration in the blood.

Research on the alcohol concentrations in the blood of drivers and victims of accidents serves as a base for the evaluation of counter-measures. The heightened probability of meeting with an accident as a result of alcohol consumption is taken for granted (e.g. Borkenstein, 1964). Repeating this research in the Netherlands is not considered to be possible in a short space of time.

#### B. Counter-measures against alcohol

3.6.4. Research into an improved method of breath analysis for medical and legal purposes in the future (establishing a legal maximum permissible alcohol concentration in the blood).

3.6.5. Research on the effect of counter-measures:

- a) A legal maximum permissible alcohol concentration in the blood (up till now not in force in the Netherlands) or enforcement of this ruling by the police.
- b) Propaganda campaigns
- c) Counter-measures by insurance companies
- d) The effect of street lighting.

These counter-measures are mentioned as effective in the literature, some of them, especially d) deserve further research.

3.6.6. Research into the drinking habits and other personal characteristics of accident and non-accident drivers as a function of the blood alcohol concentration.

3.6.7. Research into the stability of accidents and convictions in time (recidivism as a function of blood alcohol concentration). The projects mentioned in 3.6.6 and 3.6.7 serve as a base for an evaluation of selection of drivers, a posteriori (recidivists) and a priori (alcoholics) with the expected (alcohol) accident rate as a criterion.

3.6.8. A survey of the literature regarding the existence and possibilities for a counteracting drug for alcohol consumers.

3.6.9. Research on the effectiveness of the (legal) treatment of convictions involving consumers of alcohol.

C. Visual function

Research into visual deficiencies and road accidents rates a lower priority than a more general investigation on the visual information needed in non-accident driving. The former results in relatively low utility counter-measures (selection of drivers etc.) The latter can be applied more fruitfully in for instance the layout and construction of the road. This field seems to be of great importance and deserves a research programme based on a systematic analysis of what is required of a driver.



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