

VISUAL PERFORMANCE AND ROAD SAFETY

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FOREWORD

At the request of the Information Centre "Beter Zien" (Better Vision Information Centre) in Amsterdam an exploratory study was executed on the relationship between eyesight of traffic participants and traffic safety, i.e. traffic behaviour. The results of the study are described in this report.

The data were provided by the Royal Dutch Touring Club ANWB .

The most important results were presented on 25 April 1988, when the campaign "Kijk Uit" (Watch It) was started in a conference organized by the Information Centre. They were published in June 1988 in "Oculus", the monthly magazine of the Dutch Union of Opticians NUVO.

1. INTRODUCTION

Visual information is considered to be an important input variable for traffic participants, especially for drivers.

It is to be expected that there is a relationship between visual performance and traffic ability. One might expect a relationship between visual performance and accident involvement.

Research did show, however, that there is hardly any relationship between visual performance and accident involvement.

2. ACCIDENT STUDIES

Besides a few smaller studies only two important, well executed, studies are known. The first one was directed by Burg (California, USA) and showed that there is hardly any relationship, if calculated over the whole population, between visual performance (determined in a number of ways) and accident involvement. Only the dynamic visual acuity (a visual performance that is hard to be determined and interpreted) appeared to have a significant, but weak relationship.

The second research was directed by Hofstetter (Indiana, USA) and showed a different result. This research gave special attention to the group of road users with 5 or more accidents in 3 years. In this group persons with a bad eyesight were strongly over-represented (the lowest quartile).

The following conclusions can be drawn from the results:

- there is no clear indication between visual performance and accident involvement
- in extremely bad cases of traffic capacity bad visual performance is strongly over-represented.

3. HYPOTHESES

From the results of the accident studies two hypotheses can be deduced:

- The influence of visual performance on accident involvement is smaller than often is expected.
 - Persons with a bad visual performance compensate for this incompetence.
- Both hypotheses can be made plausible.

The first: It is known that especially errors in the decisive processes, and especially errors in the setting of priorities, lead to accidents. Visual information is important, but possibly not of crucial importance in most cases: there may be abundant visual information.

The second: it is known that handicaps, and especially visual handicaps can be compensated for to a great extent. The hypotheses do not exclude one another.

4. COMPENSATION

Visual handicaps may be compensated for. Persons with a limited visual acuity or depth perception, may drive slower to have to see objects at a shorter distance. Persons with limitations in the lateral eyesight may move their heads more often. In general one may drive slower to have extra time to look. Limitations, however, in colour vision cannot be compensated for.

Compensation naturally needs practice and will be more effective when the person is aware of the problem. Information will thus be important besides practice.

Compensation costs energy - conscious or unconscious. Road users will therefore not function at their best in an other way, if they have to compensate for a lack visual acuity. Even if there is no extra accident risk driving comfort will be marred, and driving behaviour influenced. The study deals with this kind of compensation.

If drivers with a visual handicap compensate for this handicap it is to be expected that the compensation (at least to a certain extent) will appear from their driving behaviour. Some behaviour will benefit from compensation, whereas other behaviour cannot be improved in spite of compensation. Adaptations of behaviour will be discussed under 9. Finally there is behaviour that have nothing to do with visual acuity or compensation.

5. DRIVING TESTS

The Royal Dutch Touring Club ANWB has taken driving tests with experienced drivers for many years. A driving test and a visual test are made for the same person. The results of the tests have been made available for an exploratory study on the relationship between visual performance and driving behaviour. The study was financially supported by the Information Centre "Beter Zien" (Better Vision Information Centre) in Amsterdam. The visual test consisted of the testing of a number of usual criteria for visual performance:

- visual acuity (left, right, and both eyes together)
- eye muscle balance (horizontal and vertical)
- field of vision (left and right)
- depth perception
- cooperation both eyes
- performance to see colours

The results have been given in three levels: good, moderate and bad.

The driving test consisted of a one-hour test drive over a certain circuit under supervision of a passenger-examiner. Drivers were tested in 124 aspects and activities, of which 7 regarding visual performance. Furthermore a total judgment was given of a number of aspects of driving, one of which was "perception and traffic insight". The two tests will first be discussed separately and then in their relationship.

6. VISUAL TEST

In Table 1 the data of the visual test are summarized. A total of 2124 persons were tested. Besides the number and percentage of users of glasses the number and percentage of "not good" is given. The qualifications of ANWB have been used, in which the limit between "good" and "not good" is not clear. The visual tests were executed when the glasses were used, so inclusive of the available corrections.

The number of persons for whom the visual acuity is less than good is strikingly high, as it is for depth perception. Some 20% of the persons tested have an anomaly. Deviations in the horizontal ocular muscle balance and in the colour perception are also numerous (almost 8%, resp. more than 9%).

A second striking aspect is the obvious decrease of the visual abilities with age. The group "older than 70" has dramatically lower abilities than the average.

Not all persons taking part in the visual tests took the driving test. The exploratory character of this research does not permit an analysis of the combined data regarding age.

7. DRIVING TEST

The driving test consisted of driving a certain route under the supervision of an examiner. The data of ANWB affect 1964 driving tests. Errors have been registered and judgments made in a subjective but systematical way. As said before the judgment was based on 124 points for which errors might be indicated. There were also 5 more general judgments for which "report marks" were given.

By far the largest part of the 124 points regard the general use of the car and traffic participation. 7 points regard perception. For this subject are important:

- 17.2 Perception of traffic, road, and environment as a whole
- 17.3 Conscious perception of traffic signs and signals.
- 18.1 Look ahead

The judgment of "perception and traffic insight" is also important. It is given on six levels. To get a better coherence the following figures are used: 9 (very good and good), 7 (amply sufficient), 6 (sufficient), 5 (mediocre), and 3 (insufficient).

In view of the limited scope of the study only parts directly regarding perception have been taken into account, see Table 2. The other subdivisions based on age, driving experience etc. have not been studied. A further analysis might be the scope of further research.

8. COMBINATION OF VISUAL TEST AND DRIVING TEST

The results of both tests of 903 persons are available. Further statements regard these 903 results. A further split is not possible on the basis of

this exploratory research. A subsequent research will treat this. Even a sample of 900 may not be sufficient for a deeper split, though.

The data of the analysis are summarized in Table 3. Considerable differences appear between the groups "good" and "not good" regarding the different criteria. Without further analysis it can not be objectively determined whether these differences are statistically significant. Finally there appears to be a coherence between the variables "acuity of two eyes" and "depth perception". It means that a person registered in one group as "not good" will probably be registered as such also in the other group.

9. DISCUSSION

From Table 3 persons registered in the "not good" group appear to be over-represented in some errors, but under-represented in others. This phenomenon is elaborated in Table 4. Here the relative differences are given of the cases "not good"; the total number of "not good" has been taken as "100%". The sample of 903 appeared to be subdivided as:

- visual acuity (both eyes): "not good" 17.4%; "good" 82.6%
- depth perception "not good" 16.9%; "good" 83.1%.

The values of 17.4% (resp. 16.9%) have been taken as "100%" for the comparison in Table 4. Note that the percentage "not good" of the sample is below that of the larger group of persons with a visual test only (Table 1).

In Table 4 the relevant questions have been subdivided according to the measure compensation of the visual performance is expected to be possible. It seems difficult to compensate for "observation of traffic, road, and environment as a whole (17.2)" and "other" of the group "traffic insight". It seems quite well possible to compensate for "conscious perception of traffic signs and signals (17.3)". This opinion seems to be supported by the data of Table 4. A deeper analysis is necessary, however. Persons with problems in the perception of colours also appear to compensate for it.

The view that limitations in acuity of vision and in depth perception have a negative influence on driving behaviour, but that a limitation in colour

vision has not, seems to be supported by also by the result of the "general judgement of perception" (Table 3). Generally persons who are "not good" in acuity of vision and depth perception are judged worse than average, but persons with "not good" in vision of colours are not. Especially among persons with "insufficient" the persons with "not good" in visual performances are over-represented.

10. CONCLUSION

Persons with vision acuity below average do not appear from literature to be systematically more often involved in accidents than others. In the small group of people who are often involved in accidents they appear to be strongly over-represented.

This suggests that there may be a certain compensation. Comparison of the visual test and the driving test results seems to support this suggestion: persons with limitations in visual performances make more errors than average in the tasks offering small possibilities for compensation, but less in tasks offering considerable possibilities.

Even though the relationship between visual handicaps and accident involvement seems to be weak it is recommendable to make the visual performance as good as possible. For the need to compensate demands effort, and exertion of effort may influence driving negatively. On the other hand there does not seem to be a reason to prevent persons with a small problem in visual performance from driving, because of the compensation.

More in general a considerable number of road users appear to have a visual performance below the optimum. Especially older persons have this problem and experienced road users are also among them. The main problems are vision acuity and depth perception.

	All ages		60-69		over 70	
	N	%	N	%	N	%
Total number	2124		190		148	
Glasses	830	38.1	129	67.9	113	76.4
"Not good"						
Visual field right	50	2.4	13	6.8	26	17.6
Visual field left	41	1.9	14	7.4	17	11.5
Balance vertical	101	4.8	15	7.9	12	8.1
Balance horizontal	165	7.8	23	12.1	22	14.9
Acuity two eyes	464	21.8	82	43.2	102	68.9
Acuity right eye	494	23.3	83	43.7	98	66.2
Acuity left eye	467	22.0	68	35.8	98	66.2
Depth perception	378	17.8	43	22.6	55	37.2
Cooperation eyes	88	4.1	12	6.3	14	9.5
Colour vision	195	9.2	29	15.3	42	28.4

Table 1. Results ANWB visual tests.

Registered errors	Sub total	%
<u>17 Perception</u>		
17.0 No errors	51	2.6
17.1 Vision technique	143	7.3
17.2 Perception total road, traffic, environment	767	39.1
17.3 Conscious perception of signs and signals	998	50.8
17.4 Use of road signs	5	0.3
Total	1964	100
<u>18 Traffic insight</u>		
18.0 No errors	293	14.9
18.1 Look ahead	371	18.9
18.2 Taking into account traffic influences	850	43.3
18.3 Reaction on perceptions	426	21.7
18.4 Strategy	24	1.2
Total	1964	100
Total judgement		
<u>Perception and traffic insight</u>		
Excellent	1	0.1
Good	189	9.5
Amply sufficient	659	33.5
Sufficient	785	40.0
Mediocre	264	13.4
Insufficient	65	3.3
Unknown	1	0.1
Total	1964	100

Table 2. Results ANWB driving tests

	Visual ac.		Depth perc.		Colour vision		Total (incl. unknown)	
	"not good"		"not good"		"not good"			
	N	%	N	%	N	%	N	%
17 Perception								
17.0 No errors	3	13.0	2	8.7	3	13.0	23	100
17.2 Perc. total	77	20.6	76	20.3	17	4.6	374	100
17.3 Signs	70	16.2	62	14.3	16	3.7	435	100
Other	7	9.9	13	18.3	1	1.4	71	100
Total	157	17.4	153	16.9	37	4.12	903	100
18 Insight								
18.0 No errors	24	15.1	29	18.1	9	5.7	160	
18.1 Look ahead	24	11.9	29	14.4	5	2.5	201	
Other	109	20.2	95	17.5	23	5.3	542	
Total	157	17.4	153	16.9	37	4.12	903	

General judgement perception	Visual ac.		Depth perc.		Colour vision		Total
	"not good"	"good"	"not good"	"good"	"not good"	"good"	
9	12	60	13	60	5	68	73
7	36	239	37	238	11	261	275
6	59	301	61	300	12	349	361
5	33	123	31	126	7	150	157
3	17	20	11	26	2	33	37
Average	5.92	6.32	6.08	6.29	6.35	6.25	625

Table 3. Combination visual tests and driving tests

	Relative increase number errors	
	Visual acuity	Depth perception
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<u>Difficult to compensate</u>		
17.2 Perception total	118.4	120.1
18 Other	116.1	103.6
<u>Easy to compensate</u>		
17.3 Traffic signs	93.1	84.6
<u>Neutral</u>		
17 Other "perception"	56.9	108.3

Table 4. Relationship between visual handicaps and compensation

