Cognitive organization of roadway scenes

An empirical study

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Drs. C.M. Gundy
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SWOV Institute for Road Safety Research, The Netherlands

SWOV Institute for Road Safety Research
P.O. Box 170
2260 AD Leidschendam
The Netherlands
Telephone 31703209323
Telefax 31703201261

Summary

The present report describes a series of studies investigating the cognitive organization of road-way scenes.

These scenes were represented by still photographs taken on a number of roads outside of built-up areas, which were used by Oei and Mulder (1993) in their study of driving speeds. Sites were stratified by two regions (the Western and the South-Eastern regions of the Netherlands), three road situations (curves, intersections, and straight-road sections), and the seven road classes used by Oei and Mulder (op. cit.):
Class 1: dual carriageway highways (100 km/h speed limit);
Class 2: single carriageway highways (100 km/h);
Class 3: dual carriageway roads closed to all 'slow traffic' (80 km/h);
Class 4: single carriageway two-lane roads closed to all 'slow traffic' (80 km/h);
Class 5: single carriageway two-lane roads closed to bicycles and pedestrians (80 km/h);
Class 6: single carriageway two-lane roads open to all traffic (80 km/h);
Class 7: single carriageway one-lane roads open to all traffic (80 km/h).

Seventy-eight drivers, stratified by age and sex to mimic the Dutch driving population, participated. Subjects were recruited from the population of readers of a local shopping newspaper, students, and administrative SWOV personnel.
Six studies were conducted.

In the first study, subjects were asked to sort the photographs presented to them into piles of similar photographs. These piles were intended to be 'meaningful' and 'useful' to the subjects (as determined by the subjects themselves) in their roles as automobile drivers.

The sorting data was then collected into similarity matrices, and analyzed by means of Multi-Dimensional Scaling and Analysis of Variance.
The results were quite clear. When drivers (in their role as drivers) view a road scene, three factors (on average) are of primary importance:
- the presence of an intersection;
- the number (and breadth) of carriageways;
- the presence of a curve.

In a second study, the same subjects were again asked to sort the same photographs into new piles on the basis of two new criteria:
- the different types of problems that in-experienced drivers might have;
- the other types of traffic that the subjects might have problems with.

In other studies, other subjects:
- sorted homogenous subsets (as determined in the first two studies) of the same photographs;
- named differences in pairs of widely different photographs (as determined by the previous study);
- estimated a safe driving speed and the chance of encountering 'slow' traffic for each of the above mentioned photographs;

- learned to classify each photograph in a pre-determined category. Some subjects learned the seven classes mentioned above; others learned seven categories derived in the first two studies.

The results of these studies generally re-emphasized the three factors mentioned above, while adding additional nuances.
In general, the distinctions mentioned above are very easy to learn and apply.
The categories based on the seven road classes mentioned above, on the other hand, are much more difficult to identify, to learn, and to apply, at least on the basis of local, road-side information. It is suggested that this problem could give rise to safety problems.

Finally, a number of suggestions for future research are made, and it is proposed that psychological models of road user behaviour be explicitly studied.

Contents

1. Introduction

It is generally accepted that road administrators (should) apply some form of categorization or standardization in the form and intended use of the road network. One of the purposes of this standardization would be to somehow regulate road user behaviour, by indicating what is to be expected of them. This would then increase the predictability of road user behaviour, with attendant safety benefits.

It is also generally assumed (with good reason) that road users act *as if* they apply some form of categorization of road situations, which may have consequences for their behaviour.

We have some indication of how road administrators categorize roads, at least at a formal level.
Unfortunately, we have hardly any idea of the categories that road users may apply. Nor do we know how these categories develop in time (although we must assume that it is a function of initial training and practical experience).
Finally, we also have no idea how a formal road categorization system, either existing or proposed, would actually mesh with what road users already know. To the extent that this last possibility is unforeseen, enormous conflicts, between one and the other, could arise.

To a great extent, future road systems will become safer by practically eliminating the possibility of unsafe behaviour.
However, we may also wish to believe that some form of standardization will promote desirable behaviour (and thus, safety). To the extent that the 'wish to believe' is outpacing the ability to know, we can only state that the traffic safety world is suffering from an enormous research blind spot.

2. Background

While much work has been done in subjective risk assessment and esthetic experience of road-way scenes, road-user-centred subjective categorization has been largely ignored as a subject of study.

We know of two major exceptions. First of all, we refer to the work of Riemersma (1988a, 1988b) in the Netherlands, and of Fleury and his colleagues (1991a, 1991b; 1993) in France. Unfortunately, both groups of studies are rather limited in their generality.

Riemersma selected triads of road scenes which he presented to subjects. Subjects were asked to divide the three scenes into two groups and to mention the primary difference between the groups. All scenes were then scored on these differences and the results were subjected to a number of multivariate techniques.
There are several problems with the application of this technique.
First of all, the number of possible triads (of scenes) is a cubic power of the number of scenes. Twenty-five scenes yields almost 14,000 possible triads. Since it is impossible to present all possible triads, one must make a selection. However, seemingly innocent and small differences in selection procedures can have enormous consequences in final results. For this reason, it is absolutely necessary that procedures be clearly spelled out.
Secondly, all of the resulting score data (hundred or even thousands of variables) has to be reduced. Some of this reduction may be done subjectively, in which case the previous remark remains applicable. More 'objective' reductions may be consciously or unconsciously biased by 'loading the deck' against some possible interpretations.
Third of all, one must obtain some estimate of *how important* a difference is for road users. It is potentially misleading to simply state that a (nameable) difference exists.
Finally, one should realize that mathematical techniques, such as multivariate clustering techniques, yield *representations* which *may* have some relation to road user categories. They are only hypotheses, which may be tested, and are not the 'actual things' themselves.

These criticisms may sound rather general.
However, the problem in the present case is that are situations wherein it is possible to generate everything *but* important subjective categories, by using the technique in the manner described by Riemersma. Such a 'worst case' is highly unlikely, and there is a continuum between 'worst' and 'best' possible representations. Unfortunately, we cannot determine where these studies lie on the continuum. As such, the validity and generality of Riemersma's results are difficult to assess.

Regardless of diverse criticisms, we view Riemersma's work as breaking new ground, for (from the viewpoint of the present report) his work is asking essential questions.

The work of Fleury and his associates has only recently become (somewhat) available to the present author. It is not possible, at this moment, to cover their entire oeuvre, mainly due to language difficulties. In general, however, we'd like to remark that our impression of the work of Fleury et al. is that it is generally quite skilfully done.

First of all, instead of using the method of triads (which is cubic in the number of objects) or paired comparisons (which is quadratic), they used a sorting procedure (which is only linear in the number of objects). (See van der Kloot & van Herk, 1991; Kruskal & Wish, 1978 for examples.) Among other things, the analysis of an enormous number of (verbal) labels was thereby avoided.
The big advantage here is that one can score an enormous amount of material in relatively little time. A disadvantage is that individual differences are more difficult to investigate.
Secondly, Fleury et al. treated road scene categories as a hierarchal taxonomy, and systematically added and deleted branches of this 'tree'. This, however, would be problematical if road scene categories were more veridically treated as 'tangled heterarchies', or as a hierarchy with a completely different structure.
Third of all, Fleury and his associates showed a great deal of sophistication in their use of multivariate analysis techniques. Unfortunately, this sophistication occasionally resulted in using the data as a vehicle to compare techniques. As a result, clarity sometimes suffered.

As may become apparent in the course of this report, we feel a great deal of affinity for the work of Fleury and his colleagues.
One thing that troubles us though, is that neither of these studies actually involved testing psychological models of categorization. Some mention is made of Rosch's early work in the seventies on prototypes.
However, the consequences of Rosch's work for these studies is hardly clearly. Alternative models, or formulations, are not mentioned, much less tested. We can only deplore the enormous lack of application of existing psychological models in the field of traffic safety research.

3. Objectives

As indicated in the first chapter, understanding of road-user categorization (of road situations) underlies many assumptions of how we should more safely organize the driving task.
In the second chapter, we indicated that there is almost no empirical and even less theoretical work done to bolster this understanding.
One cannot hope to remedy this situation with a single research report. The present report hopes at least to achieve two rather mundane objectives.

First of all we wish to describe the major dimensions along which road users evaluate road scenes. Of course, there would be limitations in generality, and we will encounter handicaps in the methodology chosen. However, we would hope that the results would be sufficiently 'hard' and general enough to provide an adequate initial description of the situation in the Netherlands.
Secondly, we would like to create a calibrated archive of road scenes. Again, there will be limitations in generality. However, careful (future) experimentation demands a preliminary quantification of the experimental stimuli used. We feel that one should build from a well understood, relatively simple, basis; research situations become extremely complex soon enough.

There are other, subsidiary, goals pursued in the course of this study. For example, we wanted to investigate the 'transparency' of existing road categories by comparing them to a more psychologically-based categorization scheme.
We also wanted to investigate the degree to which existing road categories, with their attendant speed limits, can be derived from roadway scenes.
However, these secondary goals may be viewed more as 'after-thoughts' than as primary objectives.

Of course, the primary, long-term objective of the present study is to provide two building blocks to the basic task of proposing, evaluating, and *using* psychological models of road-user categorization of road situations. A coherent body of empirical and theoretical results could be of great value when developing future roads, or training future road users.

4. General Overview Experiments

4.1. Introduction

The original project planning envisioned at least two major products:
- a description of the major dimensions along which road users evaluate road scenes;
- a library of road scenes quantified along said dimensions. This product would find its main use in following experimental studies.

To this end, we planned a series of three primary experimental activities. First of all, we would ask subjects to *Sort* photographs into piles, such that similar photographs end up on the same pile and that dissimilar photographs end up on different piles.
We would then construct a similarity matrix, on the basis of this data, which would then be analyzed by means of Multi-Dimensional Scaling. See van der Kloot & van Herk (1991) for a description and evaluation of the technique.
Secondly, pairs of photographs, with large differences on the dimensions derived by Multi-Dimensional Scaling, would then be presented to new subjects. These subjects would be asked to *Label* those differences[1].
We would then attempt to reduce the verbal labels to a manageable lot. Thirdly, and finally, new subjects would then be asked to *Score* all the photographs on the dimensions just labelled. These scores could then be correlated with the scores derived from MDS, cross-validating the two approaches.

In addition to this primary project line, we hoped to implement secondary, 'offshoot' experiments, when and if resources allowed. Since this secondary line would involve reusing experimental subjects, who were 'contaminated' by participation in a primary study, the results derived from such a secondary study are weaker in a methodological sense. We will address this problem in the text when applicable.

However, as often occurs, this primary project plan did not survive contact with our subjects. Namely, as we shall see, the results from the first *Sorting* (and scaling) step were so clear that it was decided to include an intermediate *Sorting-step*, before the *Labeling-step*. In this intermediate step, we would 'zoom in' on the distinctions found in the previous step.

[1]This approach has a tremendous advantage over using other means of selecting pairs (or triads) of photographs. Namely, we know that the chosen (pairs of) photographs have important psychological differences, having just established that in the previous analyses. We have no such guarantee when using randomly selected (pairs of) photographs. Alternatively, one may choose to present (pairs of) photographs selected on some a priori basis. However, one then must gamble that the a priori arguments have some psychological validity. Unfortunately, this approach does not directly show the outcome of that gamble.

The rationale is as follows: Consider that we had offered subjects photographs of animals, which were then sorted and scaled. Assume that we had then found a clear solution in which standard taxonomical phyla were represented: mammals, fish, insects, birds, etc. Such a 'helicopter view' would be a valid representation, yet we should not assume that it adequately represents everything that subjects know about animals. If we would 'zoom in' on the mammals, for example, we could find that subjects might distinguish between primates, felines, canines, rodents, ungulates, and 'other' mammals. Zooming further in on felines, for example, would certainly make new distinctions apparent.

In addition to the advantage accrued to 'zooming in', i.e., we can make distinctions that were previously not visible, we also are confronted with two disadvantages.
First of all, resources were available for only three experimental sessions. Adding an intermediate step implies that the final, *Scoring-step* could not be implemented in the study reported here.
Secondly, moving down a level in a hierarchy means dealing with a much larger number of (possibly less important) subclasses. Scaling and labelling all of these subclasses requires much more work than originally intended, and possibly for only a marginal increase in information.

In any case, the following table presents labels for the phases of the intended as well as actual primary research line:

	Primary Research Line	
Research Components	As originally planned	As implemented
Sorting	I.1.a	I.1.a
Sorting Subclasses	Not applicable	I.2.a'
Naming	I.2.b	I.3.b'
Scoring	I.3.c	Not implemented

Figure 1. *Primary Research Line*

In addition, the following table labels the elements of the secondary research line[2].

	Secondary Research Line	
Research Components	As originally budgeted	As implemented
Sorting (alternate instructions)	Not applicable	II.4.a
Estimating driving speed and 'slow traffic'	Not applicable	II.5.a'
Learning traditional and alternate categories	Not applicable	II.6.b'

Figure 2. *Secondary Research Line*

[2]These activities were not budgeted beforehand, and were implemented only to the extent that resources for the primary research line remained unused.

The labels in these previous two tables have the following meaning:
- the Roman numeral refers to the primary and secondary research line;
- the Arabic numeral refers to, more or less, independent experimental activities;
- the alphanumeric code refers to the experimental session in which the activity occurred.

4.2. General Methods

The experiments mentioned in the previous section all have their own specific procedures and objectives, which will be reported in the appropriate section. Nevertheless, every study made use of the same library of images, the same apparatus and standard software, and the same pool of subjects.

To prevent repetition, the following sections will describe aspects common to *all* studies mentioned in this report. Departures from these standards will be mentioned when relevant.

4.2.1. *Materials*

This study used (photographic) images of roads located outside built-up areas. The actual material used was the result of a series of selections and processes.
Namely, we first selected a medium, then road locations and moments in time, and finally, actual images. These images had then to be converted to a form compatible with existing hard- and software. We will discuss each of these aspects and the resulting choices in turn.

Photographs as a Medium
We chose to use photographic images, instead of other types of images. We deemed photographs to represent a suitable choice in the trade-off between cost and veridicality, at least for the present exploratory study.

Road Locations
Our choice of road locations was motivated by the existence of a previous study on driving speeds on Dutch roads outside built-up areas (Oei & Mulder, 1993). This study established a well-received and documented sample of roads outside built-up areas, stratified by geographic location (in the Netherlands) and road class.

Both convenience (for the present study) and compatibility (with Oei & Mulder) would argue that our sample of road locations should be based on that original study.

First of all, we adopted Oei & Mulder's road classification scheme:
Class 1: dual carriageway highways (100 km/h speed limit);
Class 2: single carriageway highways (100 km/h);
Class 3: dual carriageway roads closed to all 'slow traffic' (80 km/h);
Class 4: single carriageway two-lane roads closed to all 'slow traffic' (80 km/h);
Class 5: single carriageway two-lane roads closed to bicycles and pedestrians (80 km/h);
Class 6: single carriageway two-lane roads open to all traffic (80 km/h);

Class 7: single carriageway one-lane roads open to all traffic (80 km/h). Please note the absence of dual carriageway interstate (and national) highways, with even higher speed limits.

This classification scheme, while differing in some respects from other schemes in vogue, has the advantage that it takes speed-limit, number of carriageways (and lanes), and types of permitted traffic into account. As such, it could be viewed as a reflection of applicable legal distinctions in permitted traffic behaviour, as well as engineering practice.

We then selected two general regions in the Netherlands: the West (consisting of the provinces South Holland and Utrecht), and the South-East (consisting of the provinces North Brabant and Limburg). This choice was made in order to insure some systematic regional variation in roads, albeit at the sacrifice of generalizability to the entire country. This choice was made purely for practical reasons.

The roads in the Oei & Mulder sample were either discarded (if they did not fall in the selected regions) or put into one of (7 road classes x 2 regions) 14 hats. Not all hats were equally well filled, some road types being rather uncommon.
If possible, three roads (and one alternate) were then drawn from each hat[3]. See *Appendix 1* for a list of the roads actually used.

A protocol was also developed for determining how the actual photographs were to be made (and other information gathered), once a road had been chosen:
An automatic 35mm camera, with a 50mm lens, was mounted on a tripod fastened on the passengers' seat of an automobile. The camera was oriented through the front windshield along the major axis of the automobile.
The driver of this automobile then proceeded to one of the selected roads, and located:
- the first intersection located on that road;
- the first curve at least 150 meters after that intersection;
- a straight road section at least 150 meters after the curve.

Having familiarized himself with the route and the three locations mentioned above, the driver then retraced the route from the opposite direction and made a photograph at each of the three locations from his moving vehicle. This 'run' was then repeated from the opposite direction, for a total of (3 locations x 2 directions) 6 photographs per road.
A final 'run' was made to collect information about the locations, while *parked* in the vicinity. The form used for this purpose is found in *Appendix 2*.

[3]Two roads were exchanged with their alternates, due to their proximity (less than 5 km) from another road in the same category.

In this way, a total of approximately (7 road classes x 2 regions x 3 roads per region x 3 locations per road x 2 directions) 252 photographs were made[4].

Four points were emphasized:
- safety was the overriding priority;
- a distance of at least 100 meters from preceding traffic was necessary to ensure that other traffic would not obscure part of the photograph;
- the photographs should be made at a distance of about 50 meters from the location in question, in order to ensure a good view of that location.
- if at all possible, one should avoid including traffic signs in the photographs.

This material was collected during working hours for about fifteen days spread over the months of September and October 1993. Photographs were not collected during days with predominantly poor weather.

The negatives were developed and placed on Kodak Photo CD's. The images were then converted to sixteen grey-levels, and reduced to a size of 640 by 426 pixels. (This size fits onto a VGA screen and also preserves the original aspect ratio). The images were then translated to PCX image files. These steps were necessary in order to ensure compatibility between the images and the MEL software which would be using them (see apparatus section). Please see *Figure 1* for a general sketch of the steps necessary to prepare and present the materials to our experimental subjects.

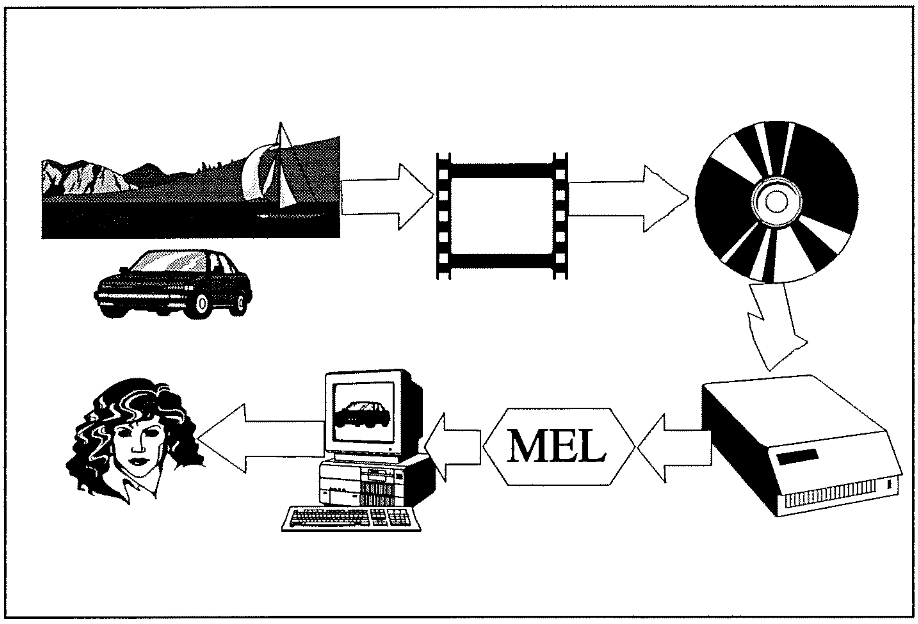

Figure 3. *Sketch of stimulus processing steps*

[4]Actually, a number of extra photographs were made for administrative and experimental purposes.

All images were then examined and those with substandard quality[5] were eliminated. After this initial process of elimination, only those roads with at least one adequate image of a curve, a straight-road section and an intersection, were further considered. Except for these two provisions, further sampling of images was done randomly.
See *Figure 4* for some examples.

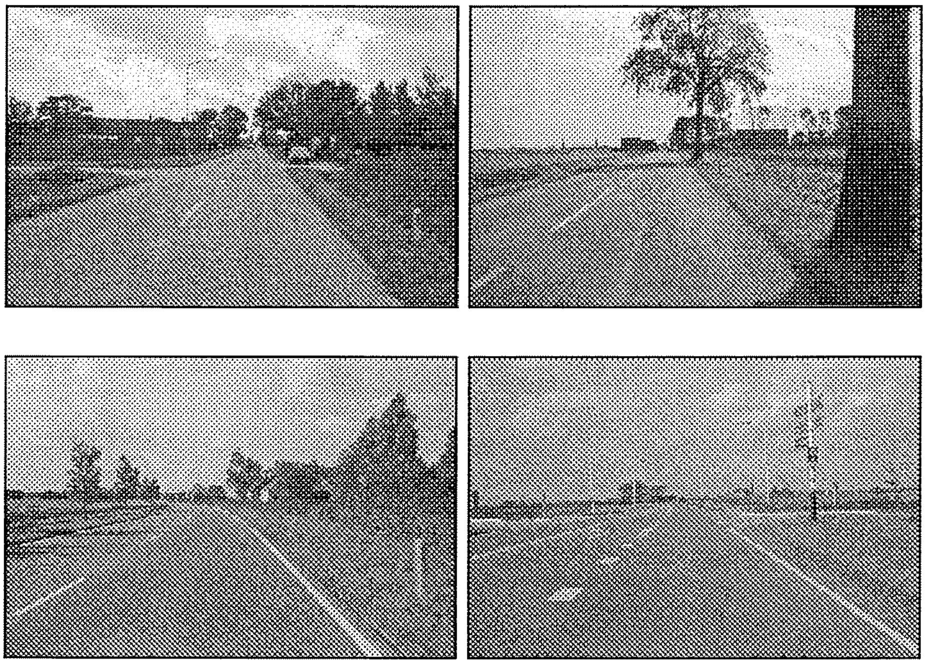

Figure 4. *Some examples of selected Photographs*

Three comments should be made here.
First of all, there seemed to be a general consensus (among colleagues and experimental subjects) that the images were clear and understandable depictions of Dutch roads. In fact, the present author was quite pleased with their quality.
Secondly, it was initially surprising to note that there was very little traffic in the photographs. It should be noted that the photographer was instructed to avoid taking pictures while closing following another vehicle. It is possible that the photographer had a rather wide interpretation of this instruction. More likely is that most of the selected roads are lightly travelled during nonrush hours (when most of the photographs were made).
Completely eliminating, or systematically manipulating, all traffic in these photographs, by means of police or software intervention, would have been prohibitively expensive.
It should nevertheless be emphasized that we sought a sample of road locations and not of traffic situations.
A third point concerns the information that was gathered at each road location (see *Appendix 2*). This data was intended as additional information to support interpretation based on other (psychological) measurements. As such, it was never intended as a data file of interest in

[5]Scratches on the film, windshield reflections, too little contrast, poor focus or mounting, etc. One image was also eliminated because it included a pedestrian standing in the middle of the road and staring at the camera from a distance of several yards.

itself. This is fortunate because, as it turned out, there are no easily available standardized instruments for doing road sections inventories. The data form and the data collection protocol are almost completely ad hoc. In addition, standard data entry software and procedures are not currently in use at the SWOV.
The upshot is that more than a small amount of expense was made in creating a computerized inventory of the road locations photographed, yet the quality thereof is questionable.

4.2.2. *Subjects*

It was clear that resource limitations precluded collecting a representative sample of road users. Nevertheless, it was felt that some, albeit crude, indication of sample quality was needed. To this end, we decided to emulate the sex and age distribution of the Dutch driving population. According to the Dutch Central Bureau for Statistics (CBS, 1991), the following numbers of people were in possession of a Class B driving licence:

	Age					
Sex	18-24	25-39	40-49	50-64	65+	Total
Males (x1,000)	527	1,646	1,000	1,062	497	4,732
Percent	11%	35%	21%	22%	11%	100%
Females (x1,0-00)	500	1,596	836	641	248	3,821
Percent	13%	42%	22%	17%	6%	100%

Figure 5. *Number of people (x1,000) in the Netherlands with a driving license in 1991, split by age and sex.*

Even though there are more male than female drivers, we decided to strive for equal numbers of male and female subjects, albeit with their respective age distributions.
We also estimated that 75-100 subjects would be needed to run the envisioned series of experiments.

We approached a potential subject population by means of an article[6] in a local shopping newspaper. We asked that potential subjects have normal (corrected) vision and a valid driving licence, be able to read the dutch language easily, and have no special fear of computers. The study would take place during office hours, and participants were offered a gift certificate of an unspecified amount.

More than eighty subjects responded. However, males of fifty years and older were heavily overrepresented; females of twenty-four years and younger and males of fourty-nine years and younger were heavily underrepresented.

[6]Our thanks to the Leidschendam's *Shopper*, which wrote and placed the article.

In order to (partially) remedy this problem, potential subjects were approached in two additional populations: university students and SWOV administrative personnel.
While this last supplement is rather unusual, we feel that it improves, rather than detracts from, the general representativeness of the final sample.

The total number of subjects (categorized by sex and age) who actually participated in one of the following studies is shown below:

	Age					
Sex	18-24	25-39	40-49	50-64	65+	Total
Males	3	13	6	13	7	42
Percent	7%	31%	14%	31%	17%	100%
Females	3	15	8	6	4	36
Percent	8%	42%	22%	17%	11%	100%

Figure 6. *Number of people participating as a subject, split by age and sex.*

Each participating subject also answered a number of questions concerning demographics and automobile use. This data will not be discussed here.

4.2.3. *Apparatus*

The apparatus used in these studies were (more or less) identical high performance, 486-DX 50 MHz, MS-DOS compatible PC's, with Tseng (ET-4000) super VGA video cards, and Samtron SC 428 TXL low-radiation color monitors. All extraneous utilities, TSRs, and drivers were removed.
The Micro-Computer Experimental Laboratory (MEL), version 1.0, was used to run all of the experiments. Since MEL version 1.0 uses only 16 color VGA, which we implemented as 16 grey shade images, these computers were more than adequate to run the experiments. Wait times (for calling up images from the hard disk) were barely noticeable, being on the order of perhaps a few tenths of a second.

The studies were all conducted in a smoke-free room, whose windows were partially shuttered to prevent annoying light reflections. Subjects were encouraged to call the experimenter if viewing conditions were sub-optimal. De-briefed subjects indicated that the images were sharp, and the viewing conditions were acceptable.

4.2.4. *Procedure*

Of course, each experiment had its own specific procedure. However, a number of aspects were common to all studies.
Every study included three breaks. Subjects worked at their own speed, the timing and length of these breaks were therefore individually determined.

The experimenter provided a verbal introduction, making use of an overhead projector and handouts. Therein information was given about the SWOV, the purpose of the study, the procedure to be followed, and a general timetable. More practical details were mentioned and materials were distributed.
Subjects were ensured that their responses would not (in fact, could not) be coupled to their persona.

Since it was not our intention to 'surprise' subjects, instructions were not only given verbally, but were also presented on the computer screen at appropriate times. Furthermore, subjects received a printed copy of the instructions. They were also encouraged to ask for help if needed. In addition, subjects were also given the opportunity to view a sample of images in order to familiarize themselves with the material.
This approach attempted to ensure that the experimental procedure was self explanatory.

Subjects were asked, when finished, to fill in a short questionnaire, and to contact the experimenter before leaving. The experimenter answered any remaining questions, and invited subjects to place their names and addresses on a mailing list for a summary of the experimental results. The experimenter also attempted to obtain an impression of subjective evaluations concerning the study[7].
Subjects were then personally thanked for their participation, and presented with a gift certificate (value of approximately US$ 15) and a pen with the SWOV logo.

An entire session was intended to require not more than two hours. Most subjects were able to finish within that amount of time.

[7]It was pleasing to note that many, if not all, subjects were quite enthusiastic about their experience. Many spontaneously offered to participate in future studies.

5. Experiment I.1.a: Sorting Photographs of Road Scenes

5.1. Introduction

The objective of this experiment is simple, and the methodology is straightforward.
The objective is to obtain a description of the primary dimensions along which road users, in their role of road users, differentiate between road scenes. It is important that we specify the road user role; otherwise, we might elicit esthetic (or other) judgements, whose relation to driving behaviour is unclear.

The methodology consists of presenting subjects with pictures of road scenes, and asking them to sort those pictures into piles. Similar pictures should be sorted onto the same pile; dissimilar pictures onto different piles. A similarity measure, which depends upon how often subjects place two stimuli onto the same pile, is then calculated. These measures may be collected into a matrix and analyzed by means of Multi-dimensional-Scaling. The method assumes either that different subject are (noisy) replications of each other, or that the final matrix represents some sort of common ground between subjects.

5.2. Methods

5.2.1. *Materials*

Eighty-four photographs (2 regions x 7 classes x 2 roads x 3 situations) (selected in the manner described in section 4.2.1) were used in this experiment.
In addition, four photographs, taken in the opposite direction of photographs already selected, and two duplicates of already selected photographs were selected to appear in the final set. These six additional photographs were intended to index sorting reliability.
For a general idea of the stimuli, see *Figure 2*.

5.2.2. *Subjects*

Twenty-five subjects; thirteen men and twelve women, participated in this study. See section 4.2.2 for a description of the studied population.

5.2.3. *Apparatus*

See section 4.2.3.

5.2.4. *Procedure*

In addition to the standard procedure mentioned in section 5.2.3., subjects were presented with a sample of 25 photographs drawn from the sample of 84 just mentioned. The subjects were asked to consider these photographs as if they were road scenes that the subjects may come across in their role as a driver. It was emphasized that esthetics, picture quality, and other non-functional aspects should not be considered.

Subjects were then instructed that the intention was to sort pictures (similar to the ones just seen) into piles, such that similar pictures are placed onto the same pile and dissimilar pictures onto different piles. Subjects would be presented with these pictures, one at a time, after which a pile would have to be selected. Decisions, once made, were irrevocable. Subjects were asked to spend no more than thirty seconds a picture, even though no penalty was extracted.
Subjects were furthermore asked to use at least three piles and no more than nine. Subjects were warned that the more piles they used, the more difficult it would be to keep track of them.
Pencil and paper, and a *Help* function which displayed the last four pictures placed on a pile, were to be used as memory aids.

Subjects were told that they were free in choosing how piles were to be formed: the only requirement was that it should make good sense to them in their role as a road user.
Subjects were also informed that they would be asked to describe these piles at the end of the study.
All subjects saw the same pictures in different random orders.

5.3. **Results**

Of the possible (90 pictures x 25 subjects) 2,250 responses, 49 were lost due to a software malfunction. Although these were the last seven responses of the first seven subjects, these missing data are randomly distributed over photographs: the order of presentation was random.

Of course, the similarity matrix (see van der Kloot & van Herk, 1991) had to take this missing data into account. Each cell entry was divided by the maximum number of times two objects could occur in the same pile. Subjects used an average of 5.7 piles.

They also looked at each to-be-sorted picture for an average of 7.0 seconds, with a standard deviation of 8.2 seconds. While we won't consider it further here, a quick inspection of the time series plot indicates the first few trials per subject were quite slow on the average. Study time speeded up during the course of the experiment, approaching an asymptote of about six seconds.
The *Help* facility, used to view the last four pictures laid on each pile, was only used incidentally.

To analyze the similarity matrix (describing ninety objects), we used the Multi-Dimensional Scaling routine available in SAS (1992)[8]. We fit one through five dimensions, with fits of 0.41; 0.22; 0.14; 0.11 and 0.09 respectively. We felt that the three-dimensional solution was superior.

[8]The following SAS options were used: Level=Ordinal, Coefficient=Identity, Condition=-Unconditional, Formula=1 and Fit=Distance. This boils down to a generalization of Kruskal's Formula 1.

The ninety objects are plotted in *Figure 7*: there is clearly structure in the distribution of these objects.

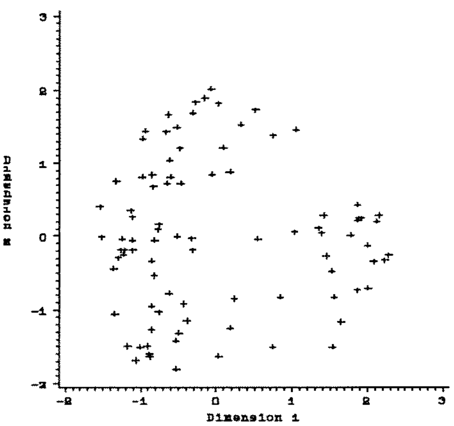

Figure 7. *First two MDS dimensions.*

To investigate the structure, we analyzed the first three dimensions in terms of the sampling variables (region, road class, and road type[9]). This was done by means of (type III) Analysis of Variance.

The results are stunningly clear:
- the first MDS dimension primarily makes the distinction between intersections and non intersections. About 76% of the variance for this dimension is explained by this distinction;
- the second MDS dimension mainly makes the distinction between dual carriageway (classes 1 and 3) roads and small, single carriageway (class 7) roads. Intermediate-sized, single carriageway roads (classes 2, 4, 5 and 6) lie in between these two opposites. About 57% of the variance for this dimension is explained by this distinction.
- the third MDS dimension primarily differentiates between curves (on the one hand), and straight-road sections, on the other. Intersections are intermediate to these two extremes. (Together with the first dimension, these three road situations form a triangle). This distinction 'explains' about 58% of the variance for this dimension.

Other main effects and interactions are not significant, with one small exception: there is a small influence of road class on the first dimension, and road type on the second. This implies that the impact of these two aspects on the first two MDS dimensions is not completely simple: there is a slight rotation. We would, however, sacrifice completeness for the advantage of clarity.

[9]Other 'objective' information was also gathered for each photograph, but was not used in the present analyses. We did not feel that this would contribute to the clarity of the present results.

See *Table 1.A* for the three ANOVA Tables, and *Table 1.B* for the parameter values. It is apparent that this description is quite adequate (at least for social science concerns). Nevertheless, it is still not perfect. There is still a substantial amount of variation that is not explained by sampling variables. Some of this variance may be idiosyncratic, due to sampling errors, or due to perceptual problems. For example, if a sideroad is hardly visible on a photograph, then some subjects will view it as an intersection, and others not. A broad, empty road in a wooded area may be a dual or a single carriageway road. It may be quite difficult to tell which is the case, if there are few other explicit cues.

Finally, a cursory investigation of the subjective category descriptions indicated that the relation with the MDS dimensions was neither simple nor evident. These descriptions were further ignored here, but see the labelling study (experiment I.3.b').

5.4. Discussion and Conclusions

We used Analysis of Variance to analyze the results of Multi-Dimensional Scaling of the similarities found between roadside photographs. These similarities were computed from a subjective sorting task of a rather general nature.

While we have not determined which physical aspects (i.e., simple visual cues) are essential for road users in order to evaluate similarity, we do know what the outcome of these evaluations is.
Simply put, road users (in the road environment as presently developed by highway engineers) distinguish between intersections and non-intersections, between double and single carriageway roads, and between curves and straight road sections.
While not exactly identical, these distinctions are also highly relevant for fundamental differences in behaviour, namely:
- the possibility of crossing-, turning-, or merging- traffic;
- the possibility of traffic from an opposing lane;
- the need to steer through curves.

A first glance indicates that these distinctions are not only reasonable, they are also essential to normal road use. However, these distinctions are not necessarily complete (diverse manoeuvres, for example, are not differentiated). Neither do they ensure that every driver is making identical distinctions.
This last point can be illustrated by considering the things that a driver may have to take into account at an intersection: cross-traffic, opposing traffic in relation to a left-hand turn, and slowing traffic (travelling in the same direction). Different drivers may differentially weight the importance of these 'threats', yet all of these threats have something in common: they can primarily occur only at intersections.

We are left with the conviction that our present findings are essential, solid, and important, yet with doubt about whether the complete story is as simple as it appears to be. While the possibilities for investigating the completeness of the above-mentioned distinctions are limited for the present set of stimuli, we can consider two further variations:

First of all, we can vary task instructions so that subjects may be forced to consider other aspects of the road situation. Secondly, we can 'zoom in' on the found distinctions. In this way, we can investigate whether the subjects continue to make stable (and interesting) distinctions, even at lower hierarchal levels.
We refer then to experiments II.4.a (chapter 6) and I.2.a'(chapter 7).

6. Experiment II.4.a: Sorting with Different Instructions

6.1. Introduction

As pointed out in the previous section, it would be useful to know how stable the found dimensions actually are. One way of considering this question is to repeat the experiment described in chapter 5 with different instructions.
Such an experiment is described in this section.

6.2. Methods

6.2.1. *Materials*

Half of the materials, i.e., 45 photographs, described in chapter 5 were used in this experiment. One of the two roads per road class and region combination was selected.

6.2.2. *Subjects*

All 25 subjects participating in this study had previously participated in experiment I.1.a (chapter 5), and, as such, cannot be viewed as naive subjects. This reuse of subjects was done purely for budgetary reasons. The consequences of this 'shortcoming' will be addressed in the *Discussion and Conclusions* (section 6.4).

6.2.3. *Apparatus*

See section 4.2.3.

6.2.4. *Procedure*

During the introduction to the experiment described in chapter 5, subjects were informed that they would repeat the sorting procedure an additional two times, albeit with fewer photographs and with different instructions. After completing the first sorting procedure (as described in section 5.2.4) subjects took a break. Upon return, they were informed that the old 'piles' of photographs had been stored away, and that they could begin anew.

Subjects were instructed, prior to the first block of this experiment to:

> "Sort the photographs into piles indicating the different kinds of problems that in-experienced drivers might have."

After sorting the 45 photographs, subjects were shown the piles that they had made and were asked to describe them as concisely as possible. They were then informed that they would begin with a final, new block, wherein they begin again, but with a final instruction.

Subjects were instructed, in the second block to:

"Sort the photographs into piles indicating the other types of traffic that they might have problems with."

One might interpret the instruction for the first block as referring to carhandling road craft, the second instruction more to (social) interaction between road users.
We do not know, however, if our subjects intepreted them in this manner. Neither did we systematically investigate the influence of widely different variations in instructions.

6.3. Results

None of the (45 pictures x 25 subjects x 2 blocks) 2,250 possible responses was missing.
Subjects used 5.9 and 5.6 piles for the first and second blocks, respectively.

Subjects looked at each to-be-sorted picture for an average of 9.2 and 9.0 seconds for the two blocks respectively. The corresponding standard deviations were 11.6 and 10.5 seconds.
Initial trials were relatively slow for both blocks, and speeded up during the course of the block approaching asymptotes of about 6 seconds or so.
The two similarity matrices for each block (each describing the responses for the same 45 objects) were initially analyzed separately, using the SAS MDS routine mentioned in section 5.3.

The results for the first block in this study were strikingly similar to the results described in section 5.3. and will not be discussed here. (See however *Tables 2.A* and *2.B*)

The results for the second block are more interesting. The first two dimensions appear to be a rotation of the first two dimensions found described in sections 5.3.: see *Tables 3.A* and *3.B*. Namely, the distinction between intersections and non-intersections, and between the types of opposing traffic (c.q., type and number of carriageways) both play a role here for the first two MDS dimensions, even though their relative importance undergoes a slight change.
It is, however, the third dimension that surprises. Namely, instead of strongly reflecting the distinction between curved and straight-road sections, such as previously found, the dominant predictor of this third dimension is the type of opposing traffic. Oddly enough, this third dimension contrasts single carriageway roads with dual carriageway roads together with small, single-lane, single carriageway roads!

Distinctions between curves and straight-road sections do remain, even though they are much reduced in importance. In addition, region play a small, yet statistically significant, role for the first time.

Perhaps this third dimension might be indicating some deep insight into how roads are experienced. Dual carriageway roads may not viewed as troublesome because there is sufficient space for everyone, and small

country roads may not viewed as troublesome because there is hardly any traffic.
We would, however, prefer to call the third dimension a 'difficulty factor', or 'horseshoe' (see, e.g., Gifi, 1981; Gundy, 1985). Horseshoes, as such, do not convey essentially new information, they only provide a better fit between nonlinear data and their representation in Euclidean space.

This last interpretation is supported by the ad hoc argument that subjects apparently do not expect unique problems with other kinds of traffic (as required by the instructions for this block) on curves as opposed to straight-road sections.

We originally intended to use MATCHALS (Commandeur) to analyze the two similarity matrices in this study, together with the (reduced) similarity matrix derived in experiment I.1.a (chapter 5). Unfortunately, the software was not available. Furthermore, K-Sets analysis software is not currently available in the SAS package.
Having no clear alternatives, we decided to apply only an INDSCAL MDS model to these three matrices, treating each matrix as an 'subject'.

While not going into any great detail, the INDSCAL results are consistent with the general description mentioned above. Namely, the first two INDSCAL dimensions are more or less the same for all three matrices, only the relative importance of these two dimensions differ somewhat for the last block. In addition, the third INDSCAL dimension is much less important for the last block, than for the other blocks. Further analysis did not appear to be fruitful.

6.4. Discussion and Conclusions

We should point out the subjects participating in this experiment were not naive: they had already participated in a previous, highly similar study shortly before. Furthermore, the presentation order of the diverse experimental instructions was not counterbalanced.

One could view this as a fatal methodological flaw, or as an inexpensive way of milking some extra information from experimental subjects.
A 'correct', between-subjects design (with three, or more, experimental instructions) is easily, albeit not cheaply, implemented. This author, however, does not believe that a between-subjects replication of the present study would lead to dramatically different results.

The primary conclusion is that, under the conditions of the present study, subjects will still tend to make the same, highly relevant, underlying distinctions that we found in the first experiment. Depending on the experimental task, subjects may weigh the relative importance of the distinctions differently, some distinctions may be lost or added.

We should, however, make two qualifications.
In the first place, even though the subjects in this study were apparently relying on the same underlying distinction, there is no guarantee that this result will always obtain. For example, other task instructions, or stimuli, subjects, etc. may produce other results.

Secondly, subjects may have widely differing category labels, intentions, or mental models: the results found here do not preclude that possibility. However, as pointed out above, the basic enabling conditions are probably common to all. For example, the presence of an intersection is a basic enabling condition for the possibility of cross-traffic, and the presence of cross-traffic is a fundamental aspect of the traffic system as we know it.

7. Experiment I.2.a': Sorting Homogeneous Sub-Sets of Roadway Scenes

7.1. Introduction

We found in experiments I.1.a (chapter 5) and II.4.a (chapter 6) an apparently robust result. Namely, even under a variety of instructions, we found, more or less, the same set of basic enabling conditions as the largest common denominator of subject sorting data.
While we might hesitate to refer to these conditions as the *basic level* of rural road categorization (e.g., Rosch, 1976), the thought has occurred to us.

The purpose of the present study is twofold. First of all, it is to attempt to find a more refined coding scheme for road scenes. We hope that we can fulfil the spirit, if not the letter, of the original project proposal. A second purpose is embroiled with the first: we want to investigate the fine structure of road scene categorization. In the present case, we will ask how this structure appears under the microscope, when we zoom in on homogeneous groups of road-side scenes (homogeneous, in the sense of the findings of experiment I.1.a, chapter 5). Do we find strong evidence of structure even at lower levels, or do things become more fuzzy as we continue to ask for finer distinctions? A finding of the second sort, for example, would argue that we have truly found something that resembles a basic level.

7.2. Methods

7.2.1. *Materials*

The same materials as used in experiment I.1.a (chapter 5) were used in this study. However, no repetitions (for reliability measurements) were included. Furthermore, the basic materials were divided up into three separate groups:
1. intersections (all road classes), (28 pictures);
2. dual carriageway roads (excluding intersections), (16 pictures);
3. single carriageway roads (excluding intersections), (32 pictures)[10].

7.2.2. *Subjects*

Twenty-three naive subjects, twelve men and eleven women drawn from the subject pool described above (section 4.2.2), participated in this study.

7.2.3. *Apparatus*

See section 4.2.3.

[10]The lowest road class, consisting of small, single-lane, single carriageway roads, was excluded from this study due its' small size.

7.2.4. *Procedure*

The procedure followed here was identical to the procedure used in experiment I.1.a (chapter 5), with one important difference. Namely, three blocks, each block with the (homogeneous) sub-set of photographs mentioned above, were presented to the subjects. The presentation order of the blocks and the photographs in each block was randomized per subject. Each block was explicitly labelled for the subjects. They were also shown a sample of eight photographs at the beginning of each block in order to familiarize themselves.
At the end of each block, each subject was asked to supply a concise description for each pile of photographs.

7.3. **Results**

Of the (23 subjects x (28 + 16 + 32)) 1,748 possible responses, none were missing.
Subjects used an average of 5.5; 4.6; and 5.1 piles for respectively the intersection, the dual carriageway, and the single carriageway blocks. This is somewhat less than in the previous two studies.

Subjects looked at each to-be-sorted picture for an average of 11.4; 12.1; and 10.1 seconds for the respective blocks. Standard deviations were respectively 10.4; 10.9; and 11.8 seconds. Concerning the distribution of reaction times over trials, the picture is somewhat similar to the previous studies. Initial trials are very slow, and later trials gradually approach an asymptote.
The astute reader may have noticed that the average response time is much slower than in the previous two experiments, and the standard deviation is much larger than in the first experiment. This would have been quite an exciting discovery if it were not for the fact that the blocks in the present experiment have relative few later, and much faster, trials. If we consider only the first twenty-five trials or so in the first two experiments, numbers similar to the one presented here are obtained.
Let us consider the MDS Results for each of the three blocks in turn.

Intersections
The fits for one though six dimensions were respectively, 0.35; 0.22; 0.15; 0.10; 0.08; and 0.07.
Let us consider the three-dimensional solution, which has a fit approximately equal to the fit selected in the previous analyses.

We analyzed the 3D MDS dimensions by means of three ANOVA's, with the sampling variables as independent variables (see *Tables 4.A* and *4.B*). This procedure parallels the procedure as described in section 5.3, with the exception that not all sampling variables and interactions can be used. This is, of course, due to the partitioning that we applied in isolating blocks of photographs: here we are only analysing intersections.

As opposed to the general findings in section 5.3, *no* predictor variables, with one exception, play any statistically significant role, for any of the three MDS dimensions. The exception is 'road class' for the first dimension: it 'explains' about 54% of the variance there. The first three classes of 'road class' are apparently being distinguished from the other lower, four classes. This is rather similar to the second dimension found in chapter 5, which also ordered intersections (and all other road sections) by road class.

Nevertheless, we will clearly need some new information in order to describe what these dimensions are actually describing.

Dual carriageway roads (excluding intersections)
The fits for the first six MDS dimensions are: 0.39; 0.21; 0.14; 0.09; 0.06 and 0.04. We will again work with the three-dimensional solution.

The ANOVA's for these three dimensions are also somewhat disappointing (see *Tables 5.A* and *5.B*). The variable 'region' explains about 30% of the variance in the first dimension. This is not only a relatively small amount, in comparison to previous analyses, it is also of borderline significance (alpha = 0.07). Perhaps we can ignore this effect. The distinction between curves and straight-road sections does play a statistically significant role in describing the second dimension. Unfortunately, this effect 'explains' only about 31% of the variance in this dimension.
No effects even approach significance for the third dimension.

We will also need some additional information if we want to understand what our subjects are doing here.

Single carriageway roads (excluding intersections)
The fits for the first six MDS dimensions are: 0.42; 0.26; 0.18; 0.12; 0.09 and 0.07. One could argue for either a three or four dimensional solution in the present case. We will look at the simpler, 3D solution.

The ANOVA's do shed some light in the present case (see *Tables 6.A* and *6.B*). About 59% of the variance for the first dimension is 'explained' by the contrast between straight and curved road sections. The interaction 'region times road class' is also significant, yet it contributes only an explanation of an additional 12%. Furthermore it is not apparent how this effect should be interpreted. The main effects do not approach significance.

About 39% of the variance of the second dimension is explained by road class. Class five roads are contrasted with classes two and six. Class four lies in between these two extremes.
We have no idea what this contrast could mean.

Finally, (a meager) 25% of the variance found in the third dimension is 'explained' again by the difference between straight and curved road section.

7.4. Discussion and Conclusions

This study distinguishes itself from the one discussed in chapter 5, primarily in that the stimuli were presented in disjoint, homogeneous blocks of stimuli. The instructions, the (total) number of stimuli, the stimuli themselves, were more or less identical.

Nevertheless, a number of interesting things occurred. First of all, subjects were capable generating (on average) the same number of categories for *each* homogeneous block of photographs, as they generated for the all of those photographs together in the one block in the first experiment (chapter 5). That is, we found (5.5 + 4.6 + 5.1) 15.2 categories, as compared to 5.7 in the first experiment. Furthermore, analysis of the similarity matrices for each block showed that at least three dimensions were required for each matrix.

Clearly, our subjects are capable of generating finer, more detailed, distinctions than we found in our first study. A corollary of this finding is that subjects had to pay additional 'start-up' costs in order to do so. Namely, each time they started a new block of photographs, their response times slowed down dramatically and the standard deviations increased. However, describing the 'fine' distinctions being made is hardly easy.
To some extent, our original explanatory variables (road class, and type of road sections) reasserted themselves, even though we had done our best to remove their influence by partitioning them into subclasses. For example, if we only consider intersections, then distinctions between curves and straight-road sections are clearly not relevant; number of carriageways did turn out to be of some importance. If we consider only dual carriageway roads, with the exclusion of intersections, then neither the presence of intersections nor the number of carriageways can possibly pay any role; the distinction between curves, etc. can.

To summarize, even if we (partially) break up the category structures that we found to exist, then subjects are nevertheless able to work with the remaining important structures. In addition, they are able, albeit at some cost, to make additional, finer distinctions.
Unfortunately, we do not know, at this moment, what these additional, finer distinctions might be. That is the purpose of the following study.

Incidentally, it might be interesting to pursue this type of study (with suitable adjustments) even deeper into microscopic distinctions. The question is whether we can continue to find a large common denominator, as in the present case, or whether structure (i.e., stable MDS dimensions) will dissolve at lower levels. In other words, how far can we descend into specifics before road-user cognition becomes clearly idiosyncratic?

8. Experiment I.3.b': Labelling the Common Denominators

8.1. Introduction

In the previous chapter, we described a study wherein we derived three important underlying dimensions for each of three homogeneous blocks of road-scene photographs. The problem, however, was that we were rather uncertain as to how we should label those dimensions. In the following section, we will describe a study wherein we present pairs of photographs (which differ on the previously mentioned dimensions) to subjects, and ask them to describe the difference between the presented pair.

It should be noted that this approach has an advantage above presenting randomly chosen pairs of photographs. Namely, in the present case, we know that there is an important difference between photographs, having just derived that fact from previous studies. Randomly chosen pairs, on the other hand, may or may not have an important difference. If a difference is mentioned, there is no way of distinguishing an important one from a trivial one.

8.2. Methods

8.2.1. *Materials*

As mentioned in chapter 7, three (homogeneous) blocks of photographs were selected:
1. intersections;
2. single carriageway roads, excluding intersections;
3. dual carriageway roads, excluding intersections.

These blocks were presented to subjects to be sorted. The sorting results were analyzed by means of MDS, which resulted in (approximately) three important dimensions per block. Per dimension, three pairs of photographs, which had a large difference for that dimension, were selected. A total of (3 blocks x 3 dimensions x 3 pairs) 27 pairs of photographs was selected.
It was intended that the 9 pairs per block should exhibit 'simple structure', i.e., that each pair has a large difference on one and only one MDS dimension. Furthermore, it was (originally) intended that a photograph only appears once in the present study. Unfortunately, neither of these intentions was achieved, partially due to the small (greatly reduced) number of photographs in each homogeneous block.

8.2.2. *Subjects*

Twenty-three subjects, twelve men and eleven women, participated in this study. Unfortunately, the data for five subjects (all in the same day) was completely lost due to a 'power failure'.

8.2.3. *Apparatus*

See section 4.2.3.

8.2.4. *Procedure*

Subjects were asked to concisely describe the most important difference between each of 27 pairs of photographs. They were presented with one pair at a time: first one full-screen photograph, then the second, and then both (half-sized) photographs simultaneously.
The order of each pair of photographs was randomized per subject.

8.3. **Results**

As previously mentioned, the data for five of the twenty-three subjects was completely lost.
Nevertheless, this study resulted in more than ten pages of textual remarks, which we will not trouble the reader with. Two problems became apparent, however. In the first place, S's routinely used compound descriptions. E.g., they routinely mentioned the presence of trees, the presence of a curve, and the type of right-of-way in the same description. Another example involves the presence of street lighting and the presence of bushes along the road.
The second problem involves an occasionally 'abstract' description: roads are 'dangerous', 'active', 'boring', etc.
Unfortunately, it is only occasionally that subjects use the same terminology, such that we can directly use their descriptions.
Therefore, in the following, we will only present what we qualitatively feel to be the common denominator derivable from our data.

Concerning the group of Intersections, the first MDS dimension apparently discriminates between intersection with and those without traffic lights. Also mentioned is the presence of turning arrows on the pavement and turning lanes. Apparently this dimension discriminates 'complex' intersections from the simpler ones. The second MDS dimension seems to refer to the difference between entrance and exit lanes on dual carriageway roads and 'classical' intersections, mainly on single carriageway roads. The third MDS dimension involves differences in street lighting, the quality of road markings, the breadth of the road, and the possibility of a good 'overview' of the road situation.
The first and second dimensions seem to be clearly interpretable.
The third is understandable, yet is unfortunately not entirely clear the extent to which it is independent of the first two dimensions.

The second group, dual carriageway roads (excluding intersections), has somewhat confusing results. The first MDS dimension appears to refer to the presence of merging (?) and emergency lanes, curves, and the visibility of traffic coming from the opposite direction (in the other carriageway). The second dimension seems to concern the presence of guide rails, and whether the carriageways are actually separated or not. The third dimension appears to discriminate between guide rails and concrete barriers in the separating median.

In any case, we would not like to place too much emphasis on these results, noting that small number of photographs in this block did not easily allow for comparisons of 'simply structured' pairs.

Finally, the first MDS dimension of the third group, single carriageway roads, involves the distinction between a poorly marked curve in a 'country' road versus a straight, well-marked, 'higher order' road. The second dimension involves the presence of trees, good road marking, and curves. The third dimension discriminates between well-marked curves and poorly marked straight-road sections.
This all appears to be somewhat confusing, yet the quality of the road marking, and the presence of trees and/or curves are clearly important.

8.4. Discussion and Conclusions

This study was plagued by bad luck and by the (partially foreseeable) consequences of considering disjoint, homogeneous, blocks with smaller numbers of objects. The original intention was to select pairs of stimuli from a collection of more than eighty objects. By using disjoint blocks, we were forced, in the case of dual carriageway roads, to select nine pairs from only sixteen objects. Some objects were therefore presented in several pairs, and 'simple structure' was not obtained.
This last shortcoming may have been less noticeable if, either by nature or by our experimental instructions[11], our results had been clearer.

Nevertheless, despite these problems, a number of important points do emerge. First of all, the importance of the distinction between curves and straight-road sections is re-emphasized. Secondly, the presence of traffic lights (and their accoutrements) arises as a significant characteristic. Thirdly, the importance of roadside markings is underlined.
Finally, diverse aspects, such as street lighting, presence and type of carriageway delimiters (i.e., guide rails, medians, concrete walls, etc.), road-breadth, presence of trees and emergency lanes, etc. also seem to play a role.

These factors apparently have *something* to do with the class of the road. The ANOVA described in the previous section, for example, indicated that 'road class' was the only sampling variable which played a role in discriminating between intersections.
On the other hand, we created two disjoint blocks wherein the role of road-class was deliberately minimized, and therefore this variable could only play a dramatically reduced role.

Therefore, in describing these factors, one has to go beyond 'road class' as an explanation and consider the quality (some may say, the 'legibility') of the road itself. For example, poor road markings can be found on highspeed, dual carriageway highways as well as country roads. There may be an overall correlation between road class and the quality of the road, yet they are clearly not synonymous.

[11]By this we mean that we perhaps should have asked for the *single* most important and concrete distinction. Subjects were instructed, of course, to consider distinction important to the driving task.

While clearly subordinate to primary ‘enabling’ characteristics (such as those described above, which determine which kinds of behaviour are possible) road ‘quality’ could, perhaps, play an important role in determining road safety. It could be quite important to provide a ‘harder’ quantification of this aspect, which this present study, unfortunately, does not supply.

9. Experiment II.5.a': Estimating Safe Speeds and Presence of Slow traffic

9.1. Introduction

This section describes a study, implemented in a secondary research line, which attempts to provide an initial quantification of two important road characteristics. As we found in chapter 5, there are a number of road characteristics which are important to road users. Safe driving speed and the presence of slow traffic, are only weakly correlated with those characteristics, yet are crucially important for traffic safety, and form an essential part of the definition of our road classes.

Our question then is whether subjects are able to systematically assign safe speeds and chances of slow traffic to road scenes. If so, then we would like to know which factors play important roles in these discriminations.

9.2. Methods

9.2.1. *Materials*

The same 76 photographs described in section 7.2.1 were also used here. The basic materials, however, were not split up into disjoint blocks. It was also intended to include the class seven nonintersection roads in this study. However, these photographs were unfortunately omitted.

9.2.2. *Subjects*

All 23 subjects in this study had previously participated in experiment I.2.a' (chapter 7), and cannot be viewed as naive.

9.2.3. *Apparatus*

See section 4.2.3.

9.2.4. *Procedure*

Subjects were presented with 76 photographs per block, one at a time, and asked to type in a number which indicated:
- the 'driving speed that they felt to be safe';
- the 'chance that they might encounter slow traffic' in the road scene depicted.

The presentation order of photographs was randomized for each subjectblock combination. The presentation order of the question asked in a block was also randomized per subject.
Unfortunately, response times were not registered.

9.3. **Results**

First of all, let us consider the 'safe driving speed' variable.
Of the (23 subjects x 76 photographs) 1,748 possible responses, one was excluded as missing.

The results of a Type III Analysis of Variance are shown in *Table 7.A.* As can be seen, all effects, with the exception of the *Region * Type* interaction, are quite significant. However, with the exception of *Subjects*, the only really important effects are *Class, Type* (and possibly their interaction).
It may be noted that this model 'explains' about 50% of the total variance, which may be viewed as adequate, but hardly 'outstanding'.

The least mean squares parameter estimates, corresponding to this analysis, are shown for the *Class* and *Type* (interaction) in *Table 7.B* below. There it may be seen that Type III (corresponding to intersections) has a dramatically lower speed, 15-30 km/h, than either straight-road sections (Type I) or curves (Type II) for the corresponding road class. This is, of course, hardly surprising.
Furthermore, the difference between safe speeds on curves and straight road sections is apparently dependent on road class: sometimes (Classes 1, 3, 4 and 5) it doesn't appear to make any difference; sometimes (Classes 2 and 6) it may make a difference of 7-10 km/h. We have no ready explanation for this finding.
Thirdly, 'safe driving speed' is also clearly a function of road class. Highest speeds may be found on Class 1, followed by Class 3. Classes 2, 4, and 5 are intermediate. Class 6 has the lowest scores (ignoring Class 7 for the moment). (The difference between Class 6 and Classes 2, 4, and 5 may or may not be statistically significant depending upon the strictness of our statistical assumptions). These results are not surprising, in the light of what we have already seen. Nevertheless, it is pleasing to note that there is some more differentiation (in any case between Classes 1 and 3) than we found in the previous Multi-Dimensional Scaling studies.

For the purists, we will note that the *Region* x *Class* interaction, also of some importance, reflect the fact that safe speeds on dual carriageway roads in the SouthEastern region are judged to be about thirteen km higher than in the Western region. This may be due to a roomier or more rural nature of these roads in the less densely populated SouthEastern region.
In addition, Class 4 and 5 roads are judged to have a 5 km/h higher safe speed in the Western than in the SouthEastern region. We have no ready explanation for this finding.

Interestingly, the extremely significant subjects effect has average scores varying from 59 km/h to almost 87 km/h. Average scores for individual photographs (which we attempt to describe by the effects mentioned above) vary between 40 and 108 km/h! (A separate ANOVA, not reported here, indicated that the mean square for individual subjects was about equal in size to the mean square for individual photographs.)

Concerning the 'chances of encountering slow traffic' variable, there was no missing data.

The analysis of this data, however, left us in somewhat of a quandary. The response variable is not categorical or even binary, and therefore loglinear or logistic analyses did not appear appropriate. Linear analysis, similar to the ANOVA implemented for the 'safe speed' variable, was not appropriate either, due to the heteroscedastic error variance resulting from the upper and lower variable bounds. A variable transformation may have been appropriate, but which?

We decided to throw caution to the winds, and implement an ANOVA as before. Since we are primarily interested in substantial effects, partial failure of a statistical model would imply that we might miss a (relatively small) significant effect.

The results of the Type III ANOVA are shown in *Table 8.A*. There we see that everything, with the exceptions of *Region* and *Region* x *Type*, is quite significant. *Class, Type*, and *Subjects* have quite substantial contributions to the model, which 'explains' about 47% of the total variance, which is again, 'adequate', but hardly 'outstanding'.

The Least Mean Squares estimates for *Class* x *Type* are seen in *Table 8.B*. There it is abundantly clear that the estimated chance of encountering slow traffic is 10 to 20% higher for intersections (*Type* is equal to three) than for curves or straight-road sections, which hardly differ. Furthermore, dual carriageway roads (Class 1 followed by Class 3) have the lowest estimated chance, followed by Classes 2, 4, and 5. Class 6 has the highest estimated chance, if we ignore Class 7. Again, depending upon how stringent the decision rules are, one may conclude that Class 3 is again distinguished from Class 1, and that Class 6 is distinguished from the other single carriageway roads.
In any case, distinctions in the expectation of slow traffic is being made in a manner evocative of our previous findings (e.g. section 5.4).

Again, the extremely significant *Subjects* have average scores varying between 9 and 77%. Individual photographs (which we attempt to explain by means of the above mentioned effects) have average scores varying between 5% and 66%. (A separate ANOVA, not reported here, indicated that the mean square for *Subjects* was about four times as large as the mean square for individual photographs!)

9.4. Discussion and Conclusions

Despite lingering doubts concerning the applicability of the statistical analysis models, some striking results have been obtained.

We have found enormous differences in average scores given by different subjects. While this might be expected in the case of estimating chances (a notoriously unreliable undertaking), it is surprising that subjects have such widely different ideas about 'safe speeds'. One might be tempted to dismiss this as a sort of (irrelevant?) response bias, was it not for the fact the individual photographs also varied enormously, and in predictable ways. Namely, road *Class* and *Type* of road situation had very large impacts on the judgements collected here.

To some extent, these impacts were not very surprising, e.g., 'safe speeds' are lower and the 'chances of slow traffic' are estimated as being higher at intersections than other road sections. The same is also apparently true for single carriageway as opposed to dual carriageway roads.

It was pleasing to note that subjects were able, to a small extent, to note 'speed' and 'slow traffic' differences in the different sub-classes of single and dual carriageway roads. On the other hand, it is clear that subjects do not do this to the extent hoped for, when defining road classes in terms of 'slow traffic' restrictions. Since the ability to predict the presence of slow traffic may have enormous consequences for safety issues, this relative lack of ability is concerning.

Finally, we have found some clearly present, albeit not quite enormous, effects that admit of possible ad hoc explanations. For example, regional differences in safe speeds on dual cariageway roads are of the order of 10-15 km/h, an effect that we would rather not ascribe to differences in traffic intensity.
There are apparently *some* visible regional differences in roadway scenes.

Since 'safe driving speeds' and the chance of encountering 'slow traffic' are enormously important for traffic safety, it could be quite useful to attempt to obtain more reliable and specific results. A first step could be an in-depth, microscopic analysis of the present data. Another step could involve a 'cleaner' experimental design, intended to manipulate specific road-side elements.

10. Experiment II.6.b': Learning Categories of Road Scenes

10.1. **Introduction**

In all of the previous experiments, we have firmly established that road users are capable of recognizing differences in photographs of road scenes, they can reliably sort them into categories, and estimate safe travel speeds and the possibility of slow traffic. We have also seen that there is reliable relation between what our road users are able to do and the legal requirements and restrictions for the road classes studied here.

Unfortunately, this relation between these road user abilities and legal behavioural requirements, for a given road section, is also relatively weak. Furthermore, this relation is clearly subordinate to more fundamental 'enabling' aspects of roads: whether one has to deal with cross or opposing traffic, and whether one has to steer through a curve[12].

In the experiment described in this section, we will attempt to clearly establish the validity of these statements.
We will attempt to train two separate groups of subjects on two separate classification systems involving the same objects. One group will be taught to classify photographs based on the seven-category road-class system mentioned above. The other group will be taught an alternative classification system based on the results found in experiment I.1.a (chapter 5).

10.2. **Methods**

10.2.1. *Materials*

The 84 photographs, mentioned in section 5.2.1, were also used here.

10.2.2. *Subjects*

The twenty-three subjects, mentioned in section 8.2.2, also participated in this study. An additional ten subjects were also recruited to compensate for the lost data mentioned there. Thus, only about one third of the subjects participating in this study can be viewed as naive.

10.2.3. *Apparatus*

See section 4.2.3.

[12]It is not unlikely that behavioural aspects (e.g., maneouvres, etc.) are even more fundamental subdivision. However, we did not investigate road situations in the present studies, only road classes.

10.2.4. *Procedure*

Subjects were randomly assigned to one of two conditions: the 'standard' and the 'alternative' categorization conditions. The 'standard' condition involved the seven categories used throughout this report. The 'alternative' condition also involved seven categories, which were, however, derived from experiment I.1.a (chapter 5) mentioned above. These alterative categories, which are combinations of road class and road type, were:
1. intersections;
2. dual carriageway straight-road sections;
3. dual carriageway curves;
4. single carriageway straight-road sections;
5. single carriageway curves;
6. country-road straight-road sections;
7. country-road curves.

Subjects were told of the purpose and the organization of the study. They were then presented with a (meaningful) description of the seven categories they were to learn, with one example for each category. Subjects retained a printed description of the relevant category definitions, and were allowed to take notes.
Subjects were then presented with three blocks of the 84 above-mentioned photographs, one at a time. Subjects were then prompted to supply a category number (corresponding to the list mentioned above). After subjects chose a category, they were told whether their choice was correct and what the actual answer was.
Subjects were also place under time pressure in the manner described in experiment I.1.a (chapter 5).

We originally intended to present subjects in all conditions with the same random order of photographs for each block. Our purpose was to fit some psychological models on a trial-by-trial, photograph-by-photograph basis. This intention was not well implemented for a number of reasons. The result was that some subjects received a certain order, some subjects another, and yet other subjects received a completely randomized order. For this reason, we will act as though the order of photographs was completely randomized over trials, even though this was neither (entirely) the case nor the intention. We will, furthermore, not consider individual trials nor individual photographs in the following analyses.

10.3. **Results**

Except for the five subjects whose data was completely lost, no data was missing.

Average response time was 6.9 seconds. The first block was, on average, much slower (8.8 seconds), and the third block much faster (5.2 seconds). In addition, average response time for the 'standard' classes was 8.8 seconds, much slower than the average time for the 'alternative' classes, which was 5.0 seconds. (These differences are all extremely significant. There is also a significant interaction between block and type of category that we won't consider here). Clearly, subjects improve their response time in the course of the study, and are much quicker in the 'alternative' than in the 'standard' condition.

Concerning the percentage of correct classifications, the 'Standard' condition began with 35% correct in the first block. This percentage increased to 39% and 40% in the second and third blocks respectively. The 'Alternative' condition began much higher, 73% in the first block, and increased to 78% and 82% in the second and third blocks respectively.
These results parallel the response time results: Subjects improve during the course of the study, and the 'Alternative' categories are *much* easier than the 'Standard' categories[13].

We can furthermore consider *Tables 9.A* and *9.B* for cross tabulations of the actual category and the responses given by the subjects during the last block of presentations, split into the standard and alternate conditions. There we can see which kinds of errors are being made. For example, in the standard condition, we see that subjects confuse 100 km/h dual carriageway highways (autoweg: Category I) with 80 km/h dual carriage-way (limited access) highways (Category III), which is hardly surprising. Standard Categories II, IV, and V, are also confused, as are Categories VI and VII.

The Alternate Categories also show structure in the types of (infrequent) errors being made. There is apparently some residual confusion between one-lane country roads, and (two-lane) single carriageway roads.

10.4. Discussion and Conclusions

Generally speaking, we would be quite very sceptical of this (unplanned) experimental activity. Many things went wrong (e.g., lost subjects, mixed degrees of experience with the experimental material, unintended variations in presentation order) that this study can hardly be viewed as methodologically strong. On the other hand, the results are so extreme and so convincing that we do not believe that they can be entirely explained away by design artifacts.

These results dramatically demonstrate that a category structure, derived from what road users already consider important[14], is more easily learned than another, apparently artificial, category structure. This is true in terms of speed as well as accuracy.

Sceptics may wish to replicate this study, repairing the methodological faults. We would, however, be surprised if those results differed greatly from those found here.

We also believe that the 'experimental paradism' used here is valid for other stimuli, category structures, and experimental questions.

[13]Actually, the standard condition is slightly more difficult than the alternative condition, due to the (artificial) differences in base rate. One could achieve 14% correct by guessing in the standard conditions, and almost 21% in the alternative condition.

[14]Derive from other subjects, and from an entirely different experimental procedure.

It would be useful, for example, to investigate how special signals (such as traffic signs) or route information could be used to improve classification performance. If the present system of road classes (apparently) doesn't work very well, then we'd have to attempt to improve it.
The present study pegs two, very clear, calibration points.

We do find it unfortunate that we cannot fit models on a trial-by-trial basis for the present experiment. This, of course, is because the experiment was not entirely implemented as intended.
It is possible, however, to fit (some) models on a photograph-by-photograph basis with the present data. For example, we could consider percent correct and response time as a function of the distance between a photograph and category prototypes.
Noting that prototype models seem to be the received view in traffic safety research, it would be interesting to explicitly test their validity. This (additional) activity was, however, not implemented here.

11. General Discussion and Conclusions

11.1. **Primary Findings**

We can present our primary results quite compactly.
When drivers (in their role as drivers') view a road scene[15], three factors (on average) are of primary importance:

1. the presence of an intersection;
2. the number (and breadth) of carriageways;
3. the presence of a curve.

The results are confirmed, again and again, by different means.
If we ask subjects to sort objects in similar piles of objects, the type of instructions (whether subjects should do what they feel is meaningful, or indicate the types of problems that inexperienced drivers may have, or even the types of traffic they might encounter) hardly makes any appreciable difference.
If we zoom in on a particular subclass, holding one of the above-mentioned characteristics constant, then we find that the other characteristics continue to play a role.
We can ask subjects to estimate safe driving speeds or the possibility of 'slow traffic', and these three distinctions play a lesser, yet nevertheless essential, role. If we ask subjects to label photographs based on these three distinctions, they do so quickly and (reasonably) correctly.

A corollary of this finding is that not all existing distinctions between rural-road classes (in terms of permitted driving speeds and presence of 'slow traffic') are directly visible to the road user.
A driver wanting to take these distinctions into account would therefore have to *infer and recall* this from information previously available. Such a process would probably be error-laden, if it is performed at all.

We could attempt to confirm the primary findings mentioned above by still other means; perhaps we could even attempt to investigate whether these distinctions actually constitute a 'basic level' of road scenes. We doubt, however, that the present findings will ever be severely disputed or that an 'even-more-basic-level' will easily be found.

There is, however, one possible exception. Namely, these distinctions mentioned above are more or less confounded with behaviours, c.q. manoeuvres. The possibility of crossing, merging, or turning traffic is most relevant at an intersection. The possibility of opposing traffic is strongly influenced by the number (and breadth) of carriageways. Finally, gross steering and speed adjustments are required while driving through a curve.
In this sense, the above mentioned road characteristics 'enable' manoeuvres, being intricately inter-woven with that fundamental unit of

[15]Actually, we considered photographs of roads, more or less sans traffic, which were located outside of built-up areas.

driving behaviour. Interwoven, however, is not the same as being identical.

11.2. Future Research

It is an unanswered question whether we can disentangle the two facets just mentioned (i.e., road characteristics and permitted manoeuvres). Practical limitations (i.e., the use of photographs, available budget, lack of behavioural variability in non-rush hour traffic) discouraged the consideration of (dynamic) traffic situations in the present study. (Even if this were not so, it is also only reasonable to want to understand statics before graduating to behavioural kinematics.)
However, we would consider such an investigation to be of great importance for further untwining of this fundamental aspect of the driving task.

A second nuance parallels the first: we only considered road scenes and not road routes. Transitions from one road scene to another road scene depend upon the type of road route followed: one only rarely encounters a country-road intersection on a dual carriageway 100 km/h limited access highway (autoweg). Classification of road scenes, in the real world, could possibly also have a strong memory-dependent component. An experimental study, using the same material as here, could investigate classification accuracy and latency as a function of memory load and congruency of transitions.

A third 'shortcoming' reflects a holistic bias, perhaps encouraged by the stimuli used. That is, we have considered 'intersections' and 'dual carriageway' roads only in a global sense: we did not investigate which specific visual elements were primarily responsible for detecting an 'intersection'. This, of course, could be done with suitable computer-aided image editing. The results of such studies could have important consequences for the layout of future roads.

Fourthly, this study remained on a rather high level of analysis, even though we found, in experiments I.2.a' (chapter 7) and I.3.b' (chapter 8), that subjects are able to detect (and label) meaningful features at lower levels. (For example, subjects singled out intersections with, versus intersections without, traffic lights). Such subclasses can be investigated easily enough with the same kinds of technology used here. In that case, however, we would prefer to work with a larger database of stimuli for each subclass.

Finally, the present study only considered rural roads. A replication of this study on urban roads is clearly called for.

11.3. Practical Implications

We would hope that the results of this study might have consequences for future research and future road design. One could rightly ask, however, what the immediate implications might be for the more practically minded.

First of all, classes 2 and 3 (100 km/h single carriageway highways and 80 km/h dual carriageway roads) are easily confused with roads of other levels and speed limits. These two classes of road should be phased out, in order to prevent misunderstandings.

Secondly, 80 km/h single carriageway roads with different levels of permission for 'slow traffic' (classes 4, 5, and 6) are not readily distinguishable from each other. Since it is safer to assume that drivers' do not take 'slow traffic' into account, we should either eliminate class 6 (and perhaps also class 5), or actively and continuously warn drivers that 'slow traffic' may be present.

Third of all, intersections and curves are (rightfully) clearly important to road users, and most of the time are readily recognized. Unfortunately, drivers are not always sufficiently warned (by means of traffic signs or such) when approaching intersections or curves. Extra assistance (especially in poor lighting or weather conditions) might prove to be useful.

11.4. Four Propositions

The study reported here may be viewed from many angles. One may see it primarily as a calibration study, as a replication or methodological refinement of previous work, or as an initial attempt to systematically map road users' cognitive representation of the driving task. Regardless of the viewpoint, or of the possible significance of this present type of study, we would like to posit four propositions.

1. The research methodology used in the present study is both simple and effective.
2. Road users are capable of inferring some very essential information concerning the driving task, on the basis of (static) road-way scenes.
3. Not all of the important (?) information put into the road environment (by designers, researchers, or administrators) is directly available to road users. The present road classification system is not entirely transparent to the users.
4. Further research into safety improvements in road-way design and layout would do well to involve the proposal and critical evaluation of psychological models of road user behaviour.

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Tables and Appendices

TABLE 1.A ANOVA's for 3D Multi-Dimensional Scaling Results (90 Photographs) "Most Useful" (exp. I.1.a)

Dependent Variable: DIM1

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.44119148	0.44119148	1.50	0.2253
CLASS	6	7.33203789	1.22200632	4.16	0.0015
TYPE	2	107.21212063	53.60606032	182.34	0.0001
REGIO*CLASS	6	1.93502755	0.32250459	1.10	0.3748
REGIO*TYPE	2	0.82169772	0.41084886	1.40	0.2551
CLASS *TYPE	12	2.68059008	0.22338251	0.76	0.6879
Error	60	17.63916880	0.29398615		
Corr. Total	89	139.86553045			

Model R-squared: 0.874

Dependent Variable: DIM2

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.33874188	0.33874188	0.68	0.4133
CLASS	6	58.04635318	9.67439220	19.39	0.0001
TYPE	2	6.06765744	3.03382872	6.08	0.0039
REGIO*CLASS	6	3.41241811	0.56873635	1.14	0.3507
REGIO*TYPE	2	0.21611653	0.10805826	0.22	0.8059
CLASS *TYPE	12	6.58051764	0.54837647	1.10	0.3778
Error	60	29.94019875	0.49900331		
Corr. Total	89	107.78846249			

Model R-squared: 0.722

Dependent Variable: DIM3

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.09211152	0.09211152	0.23	0.6349
CLASS	6	3.40301514	0.56716919	1.40	0.2287
TYPE	2	39.88798352	19.94399176	49.31	0.0001
REGIO*CLASS	6	0.92893397	0.15482233	0.38	0.8872
REGIO*TYPE	2	0.26968064	0.13484032	0.33	0.7178
CLASS *TYPE	12	1.97912061	0.16492672	0.41	0.9550
Error	60	24.26888214	0.40448137		
Corr. Total	89	70.90664295			

Model R-squared: 0.656

TABLE 1.B. Least Means Squares Estimates for 3D Multidimensional Scaling Results(90 photographs) "Most Useful" (exp. I.1.a)

CLASS	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
1	0.51388758	1.09706572	0.16801029
2	-0.05004677	0.06787034	0.01541694
3	0.27440177	1.09426807	0.26530729
4	-0.21842029	-0.29331629	-0.28234190
5	-0.17092330	-0.09336148	-0.06007047
6	-0.24034300	-0.60712595	0.18975323
7	-0.32632670	-1.30030191	-0.22511285

TYPE	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
1	-0.64237776	0.34895586	-0.84525503
2	-0.95473425	-0.09422013	0.80413716
3	1.50378170	-0.26969352	0.07153038

TABLE 2.A ANOVA's for 3D Multidimensional Scaling Results (45 photographs)
'Problems for Inexperienced Drivers'
(experiment II.4.a)

Dependent Variable: DIM1

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.32347322	0.32347322	2.34	0.1465
CLASS	6	6.07739004	1.01289834	7.34	0.0008
TYPE	2	44.71895229	22.35947614	162.09	0.0001
REGIO*CLASS	6	0.94595869	0.15765978	1.14	0.3854
REGIO*TYPE	2	0.75429521	0.37714761	2.73	0.0972
CLASS *TYPE	12	3.64353012	0.30362751	2.20	0.0754
Error	15	2.06916088	0.13794406		
Corr. Total	44	63.84627734			

R-squared: 0.968

Dependent Variable: DIM2

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.28065211	0.28065211	1.32	0.2683
CLASS	6	31.32302857	5.22050476	24.59	0.0001
TYPE	2	4.77180612	2.38590306	11.24	0.0010
REGIO*CLASS	6	2.99498877	0.49916479	2.35	0.0840
REGIO*TYPE	2	0.11809767	0.05904884	0.28	0.7611
CLASS *TYPE	12	2.15057749	0.17921479	0.84	0.6112
Error	15	3.18509645	0.21233976		
Corr. Total	44	44.55372794			

R-squared: 0.929

Dependent Variable: DIM3

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.35736043	0.35736043	1.43	0.2507
CLASS	6	2.79411815	0.46568636	1.86	0.1543
TYPE	2	12.51560548	6.25780274	24.99	0.0001
REGIO*CLASS	6	0.87636192	0.14606032	0.58	0.7384
REGIO*TYPE	2	0.05169279	0.02584639	0.10	0.9026
CLASS *TYPE	12	6.16783300	0.51398608	2.05	0.0946
Error	15	3.75549712	0.25036647		
Corr. Total	44	26.59999472			

R-squared: 0.859

TABLE 2.B Least Means Squares Estimators for 3D Multidimensional Scaling Results (45 photographs)
'Problems for Inexperienced Drivers'
(experiment II.4.a)

CLASS	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
1	0.08952573	1.18059836	-0.04967007
2	0.09187150	0.24805070	0.19450890
3	0.65275499	0.99293121	-0.46138885
4	-0.13340629	0.06574655	-0.04534935
5	-0.37104746	-0.51745252	0.30688346
6	-0.44681661	-0.65028156	0.26979798
7	-0.43994655	-1.39636255	-0.10676136

TYPE	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
1	-0.71521841	0.15425207	-0.68944965
2	-0.85436736	0.28030691	0.61912664
3	1.33084376	-0.46746033	0.11661760

TABLE 3.A ANOVA's for 3D Multidimensional Scaling Results (45 photographs) 'Problems with Other Types of Traffic' (experiment II.4.a)

Dependent Variable: DIM1

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.74058475	0.74058475	2.19	0.1592
CLASS	6	30.35180083	5.05863347	14.99	0.0001
TYPE	2	16.06935686	8.03467843	23.81	0.0001
REGIO*CLASS	6	2.26244627	0.37707438	1.12	0.3980
REGIO*TYPE	2	1.04513525	0.52256763	1.55	0.2447
CLASS *TYPE	12	3.86356248	0.32196354	0.95	0.5253
Error	15	5.06159246	0.33743950		
Corr. Total	44	63.25684348			

Model R-squared: 0.920

Dependent Variable: DIM2

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.63505609	0.63505609	3.14	0.0968
CLASS	6	15.53319998	2.58886666	12.79	0.0001
TYPE	2	26.12968030	13.06484015	64.55	0.0001
REGIO*CLASS	6	1.94251281	0.32375214	1.60	0.2150
REGIO*TYPE	2	0.05006245	0.02503123	0.12	0.8846
CLASS *TYPE	12	1.95097185	0.16258099	0.80	0.6443
Error	15	3.03582565	0.20238838		
Corr. Total	44	49.65096079			

Model R-squared: 0.939

Dependent Variable: DIM3

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	1.69372171	1.69372171	9.43	0.0078
CLASS	6	9.67652955	1.61275493	8.98	0.0003
TYPE	2	1.91679181	0.95839590	5.34	0.0178
REGIO*CLASS	6	1.23453358	0.20575560	1.15	0.3840
REGIO*TYPE	2	0.39431395	0.19715697	1.10	0.3589
CLASS *TYPE	12	3.59723134	0.29976928	1.67	0.1729
Error	15	2.69317546	0.17954503		
Corr. Total	44	22.09219573			

Model R-squared: 0.878

TABLE 3.B Least Mean Square Estimators for 3D Multidimensional Scaling Results (45 photographs) 'Problems with Other Types of Traffic' (experiment II.4.a)

CLASS	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
1	1.06993114	1.01916225	-0.52737596
2	0.21927449	0.28403384	0.29422006
3	1.07219883	0.43947797	-0.14148756
4	-0.18697578	0.05716858	0.51720673
5	-0.40233436	-0.06182064	0.61021058
6	-0.69471170	-0.55619098	-0.37181900
7	-1.37938741	-0.97329382	-0.61882905

TYPE	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
1	-0.55660570	0.43015894	0.18704591
2	-0.36780409	0.69961036	-0.31942159
3	0.79497916	-1.04039622	0.03042960

TABLE 4.A ANOVAs for 3D Multidimensional Scaling Results for Intersections (28 photographs) (experiment I.2.a')

Dependent Variable: DIM1

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.14343446	0.14343446	0.12	0.7324
CLASS	6	21.96105007	3.66017501	3.11	0.0377
TYPE	n.a.				
REGIO*CLASS	6	1.31489057	0.21914843	0.19	0.9759
REGIO*TYPE	n.a.				
CLASS *TYPE	n.a.				
Error	14	16.49566554	1.17826182		
Corr. Total	27	39.91504065			

Model R-squared: 0.587

Dependent Variable: DIM2

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.13052065	0.13052065	0.14	0.7156
CLASS	6	1.16786201	0.19464367	0.21	0.9691
TYPE	n.a.				
REGIO*CLASS	6	8.10386274	1.35064379	1.43	0.2713
REGIO*TYPE	n.a.				
CLASS *TYPE	n.a.				
Error	14	13.22143333	0.94438810		
Corr. Total	27	22.62367874			

Model R-squared: 0.416

Dependent Variable: DIM3

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.43686924	0.43686924	0.37	0.5519
CLASS	6	3.07287163	0.51214527	0.44	0.8432
TYPE	n.a.				
REGIO*CLASS	6	1.48835485	0.24805914	0.21	0.9673
REGIO*TYPE	n.a.				
CLASS *TYPE	n.a.				
Error	14	16.46318490	1.17594178		
Corr. Total	27	21.46128062			

Model R-squared: 0.233

TABLE 4.B Least Mean Squares Estimators for 3D Multidimensional Scaling Results for Intersections (28 photographs) (experiment I.2.a')

CLASS	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
1	1.24458647	-0.01782041	-0.32158315
2	0.45094331	-0.28377656	0.11589131
3	1.11445685	-0.21153207	0.32035231
4	-0.63746607	0.12744098	0.46937772
5	-0.36629936	-0.04781429	0.00306292
6	-0.50052685	0.05261186	-0.01419674
7	-1.30569436	0.38089049	-0.57290437

TABLE 5.A ANOVAs for 3D Multidimensional Scaling results for Dual-Carriageway Roads (excl. intersections) (16 photographs) (experiment I.2.a')

Dependent Variable: DIM1

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	6.09661081	6.09661081	4.11	0.0731
CLASS	1	0.65678934	0.65678934	0.44	0.5223
TYPE	1	0.09258350	0.09258350	0.06	0.8082
REGIO*CLASS	1	0.01551850	0.01551850	0.01	0.9207
REGIO*TYPE	1	0.37276023	0.37276023	0.25	0.6280
CLASS *TYPE	1	0.04470154	0.04470154	0.03	0.8660
Error	9	13.33696817	1.48188535		
Corr. Total	15	20.61593209			

Model R-squared: 0.353

Dependent Variable: DIM2

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	2.33477873	2.33477873	2.91	0.1220
CLASS	1	1.44448726	1.44448726	1.80	0.2123
TYPE	1	5.26480206	5.26480206	6.57	0.0305
REGIO*CLASS	1	0.62320312	0.62320312	0.78	0.4008
REGIO*TYPE	1	0.01719469	0.01719469	0.02	0.8868
CLASS *TYPE	1	0.07417980	0.07417980	0.09	0.7679
Error	9	7.21230285	0.80136698		
Corr. Total	15	16.97094850			

Model R-squared: 0.575

Dependent Variable: DIM3

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.04662774	0.04662774	0.07	0.8033
CLASS	1	0.53924171	0.53924171	0.76	0.4057
TYPE	1	0.47470011	0.47470011	0.67	0.4342
REGIO*CLASS	1	1.44961327	1.44961327	2.05	0.1864
REGIO*TYPE	1	1.34426148	1.34426148	1.90	0.2017
CLASS *TYPE	1	0.18195158	0.18195158	0.26	0.6245
Error	9	6.37672351	0.70852483		
Corr. Total	15	10.41311941			

Model R-squared: 0.388

TABLE 5.B Least Squares Means Estimates for 3D Multidimensional Scaling Results for Dual-Carriageway Roads (excl. intersections) (16 photographs)(exper. I.2.a')

REGION	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
1	-0.61728290	0.38199957	0.05398364
2	0.61728290	-0.38199957	-0.05398364

TYPE	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
1	0.07606884	0.57362891	-0.17224621
2	-0.07606884	-0.57362891	0.17224621

TABLE 6.A ANOVAs for 3D Multidimensional Scaling Results for Single-Carriageway Roads (excl. intersections) (32 photographs) (experiment I.2.a')

Dependent Variable: DIM1

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.07192858	0.07192858	0.14	0.7096
CLASS	3	1.78117286	0.59372429	1.18	0.3440
TYPE	1	24.72546380	24.72546380	49.11	0.0001
REGIO*CLASS	3	5.16161955	1.72053985	3.42	0.0384
REGIO*TYPE	1	0.15973712	0.15973712	0.32	0.5798
CLASS *TYPE	3	0.58660922	0.19553641	0.39	0.7627
Error	19	9.56643518	0.50349659		
Corr. Total	31	42.05296632			

Model R-squared: 0.773

Dependent Variable: DIM2

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	0.44658551	0.44658551	0.59	0.4506
CLASS	3	11.04752268	3.68250756	4.89	0.0110
TYPE	1	0.00524391	0.00524391	0.01	0.9343
REGIO*CLASS	3	1.64061724	0.54687241	0.73	0.5486
REGIO*TYPE	1	0.10906486	0.10906486	0.14	0.7077
CLASS *TYPE	3	0.38683918	0.12894639	0.17	0.9144
Error	19	14.29890041	0.75257371		
Corr. Total	31	27.93477379			

Model R-squared: 0.488

Dependent Variable: DIM3

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	1.70209457	1.70209457	2.62	0.1219
CLASS	3	4.42510939	1.47503646	2.27	0.1131
TYPE	1	6.63887329	6.63887329	10.22	0.0047
REGIO*CLASS	3	0.25066748	0.08355583	0.13	0.9419
REGIO*TYPE	1	0.08421158	0.08421158	0.13	0.7227
CLASS *TYPE	3	0.57207359	0.19069120	0.29	0.8295
Error	19	12.33922999	0.64943316		
Corr. Total	31	26.01225989			

Model R-squared: 0.526

TABLE 6.B Least Squares Means Estimators for 3D Multidimensional Scaling Results for Single-Carriageway Roads (excl. intersections) (32 photographs)(experiment I.2.a')

CLASS	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
2	0.25909857	0.47163041	0.43091469
4	-0.24577406	0.08497172	-0.06331681
5	0.21130664	-0.98412751	0.20082951
6	-0.22463115	0.42752538	-0.56842739

TYPE	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
1	0.87901692	0.01280126	-0.45548303
2	-0.87901692	-0.01280126	0.45548303

TABLE 6.B (cont.)

REGION	CLASS	DIM1 LSMEAN	DIM2 LSMEAN	DIM3 LSMEAN
1	2	-0.38550921	0.43861507	0.51722995
1	4	0.06862806	0.42494884	0.19498286
1	5	0.42273045	-0.64588063	0.45145705
1	6	0.08379323	0.25485534	-0.24114762
2	2	0.90370636	0.50464574	0.34459943
2	4	-0.56017618	-0.25500540	-0.32161648
2	5	-0.00011718	-1.32237438	-0.04979803
2	6	-0.53305553	0.60019541	-0.89570716

TABLE 7.A ANOVA for 'Safe Driving Speeds' (exp. II.5.a')

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	1995.399	1995.399	9.07	0.0026
CLASS	6	50344.228	8390.704	38.15	0.0001
TYPE	2	121569.060	60784.530	276.33	0.0001
S's	22	102995.897	4681.631	21.28	0.0001
REGION*CLASS	6	25663.460	4277.243	19.44	0.0001
REGION*TYPE	2	1048.655	524.327	2.38	0.0925
CLASS*TYPE	10	13699.641	1369.964	6.23	0.0001
REGION*CLASS*TYPE	10	28443.322	2844.332	12.93	0.0001
Error	1687	371086.844	219.968		
TOTAL	1746	736782.962			

TABLE 7.B Least Mean Square Estimates for 'Safe Driving Speed'

Level of CLASS	Level of TYPE	SPEED N	Mean	SD
1	1	92	95.2391304	21.9401632
1	2	92	93.5326087	16.8140778
1	3	92	65.7065217	26.2864767
2	1	91	81.7912088	14.4979052
2	2	92	74.6195652	11.2960582
2	3	92	59.1304348	23.0933211
3	1	92	84.8913043	17.4937706
3	2	92	85.1086957	17.7277683
3	3	92	67.3369565	26.7101977
4	1	92	79.6195652	16.4288960
4	2	92	77.7608696	17.1530727
4	3	92	64.9456522	15.7329109
5	1	92	77.0652174	15.5335895
5	2	92	75.7608696	11.2400086
5	3	92	61.4130435	14.8495400
6	1	92	77.7717391	14.4755218
6	2	92	68.0434783	11.7892790
6	3	92	59.6739130	15.3852425
7	3	92	59.6195652	14.1466747

TABLE 8.A ANOVA for "Chance of Slow Traffic" (exp. II.5.a')

Source	DF	Type III SS	Mean Square	F Value	Pr > F
REGION	1	3.1631	3.1631	0.01	0.9433
CLASS	6	194123.1699	32353.8616	51.67	0.0001
TYPE	2	52228.8743	26114.4371	41.71	0.0001
Subjects	22	587682.5240	26712.8420	42.66	0.0001
REGION*CLASS	6	20519.0022	3419.8337	5.46	0.0001
REGION*TYPE	2	2748.2946	1374.1473	2.19	0.1117
CLASS*TYPE	10	17861.5096	1786.1509	2.85	0.0016
REGION*CLASS*TYPE	10	22610.8140	2261.0814	3.61	0.0001
Error	1688	1056933.4977			
TOTAL	1747	1984171.8003			

TABLE 8.B Least Mean Square Estimates for "Chance of Slow Traffic" (exp. II.5.a')

Level of CLASS	Level of TYPE	N	ANSWER Mean	ANSWER SD
1	1	92	9.4782	18.8932
1	2	92	8.4565	17.3359
1	3	92	28.8804	34.9369
2	1	92	27.1195	30.3983
2	2	92	30.2391	31.9736
2	3	92	37.7717	36.3962
3	1	92	19.5543	28.9119
3	2	92	11.6521	18.0818
3	3	92	28.9782	35.0196
4	1	92	27.8695	31.7272
4	2	92	33.7282	31.8613
4	3	92	43.6304	35.8245
5	1	92	31.3586	32.0379
5	2	92	27.7391	28.7317
5	3	92	38.5108	35.0392
6	1	92	38.9130	34.5739
6	2	92	50.5000	32.1061
6	3	92	51.6739	35.3367
7	3	92	54.2173	34.3152

TABLE 9.A Results of Experiment II.6.b'

Crosstabulation of Selected by Actual Category
Last Block, Standard Categories

Actual / Selected	1	2	3	4	5	Row Total
1	108 9.2	14 1.2	58 4.9	14 1.2	9 0.8	213 18.1
2	26 2.2	56 4.8	16 1.4	20 1.7	18 1.5	153 13.C
3	22 1.9	19 1.6	69 5.9	16 1.4	19 1.6	160 13.6
4	5 0.4	40 3.4	12 1.0	46 3.9	44 3.7	184 15.6
5	3 0.3	30 2.6	9 0.8	42 3.6	58 4.9	189 16.1
6	4 0.3	8 0.7	4 0.3	14 1.2	13 1.1	122 10.4
7	0 0.0	1 0.1	0 0.0	16 1.4	7 0.6	155 13.2
Column Total	168 14.3	168 14.3	168 14.3	168 14.3	168 14.3	1176 100.0

Crosstab Cont.

Actual / Selected	6	7	Row Total
1	10 0.9	0 0.0	213 18.1
2	13 1.1	4 0.3	153 13.0
3	13 1.1	2 0.2	160 13.6
4	23 2.0	14 1.2	184 15.6
5	19 1.6	28 2.4	189 16.1
6	45 3.8	34 2.9	122 10.4
7	45 3.8	86 7.3	155 13.2
Column Total	168 14.3	168 14.3	1176 100.0

Table 9.B Results of Experiment II.6.b'

Crosstabulation of Actual by Selected Categories
Last Block, Alternate Categories

Actual / Selected	1	2	3	4	5	Row Total
1	373 31.7	6 0.5	3 0.3	0 0.0	6 0.5	388 33.0
2	7 0.6	71 6.0	7 0.6	20 1.7	0 0.0	107 9.1
3	2 0.2	11 0.9	94 8.0	2 0.2	5 0.4	114 9.7
4	4 0.3	19 1.6	0 0.0	179 15.2	10 0.9	230 19.6
5	0 0.0	4 0.3	8 0.7	1 0.1	188 16.0	236 20.1
6	5 0.4	1 0.1	0 0.0	22 1.9	1 0.1	63 5.4
7	1 0.1	0 0.0	0 0.0	0 0.0	14 1.2	38 3.2
Column Total	392 33.3	112 9.5	112 9.5	224 19.0	224 19.0	1176 100.0

Crosstab Cont.

Actual / Selected	6	7	Row Total
1	0 0.0	0 0.0	388 33.0
2	2 0.2	0 0.0	107 9.1
3	0 0.0	0 0.0	114 9.7
4	17 1.4	1 0.1	230 19.6
5	0 0.0	35 3.0	236 20.1
6	34 2.9	0 0.0	63 5.4
7	3 0.3	20 1.7	38 3.2
Column Total	56 4.8	56 4.8	1176 100.0

Appendix 1: Locations

	Prov.	Road	CodeNumber
Type I			
West:	ZH	N57	3
	ZH	N3	2
	U	N230	2
South-East:	NBr	N261	4
	Li	N281	2
	Li	N271	4
Type II			
West:	ZH	N11	7
	U	N210	6
	ZH	N206	8
South-East:	NBr	N262	6
	NBr	N279	7
	Li	N277	7
Type III only two locations availible per region!			
West:	ZH	N15	11[1]
	U	N225	11/12
South-East:	NBr	N2	11/12
	Li	R773	11/12
Type IV			
West:	ZH	N210	18
	ZH	S17	54
	U	S6	53
South-East:	NBr	N257	20
	NBr	T405	54
	Li	T28	52

[1]This was originially location number 21.

Type V

West:	ZH	T91	56
	U	N221	24
	U	T13	59
South-East:	NBr	N268	24
	NBr	T441	57
	Li	S19	56

Type VI

West:	ZH	S40	61
	ZH	T90	62
	U	T15	62
South-East:	NBr	S303	61
	NBr	S330	63
	Li	N275	28

Type VII

West:	ZH	-	68
	ZH	-	67
	U	-	68
South-East:	NBr	-	67
	NBr	-	68
	Li	-	67

Appendix 2: Classificering Wegbeelden

FOTOSESSIE, INFO-FORMULIER. waarnemer:

Datum : ______________________

Lokatie Nr : ______________________

Wegnr 1) : ______________ of / omschrijving: ______________________

Cat vd weg : 1 / 2 / 3 / 4 / 5 / 6 / 7

Weer : onbewolkt / 1/2 bewolkt / zw bew / regen

I

Type lok : RECHTSTAND WEGVAK

Hmp 1) : van tot / anders /

Filmrol nr : ______________

Gegevens : RIJRICHTING : ---> : <---

	Foto nrs	:	:
	negatief nrs	:	:
1	rijbaanbreedte	:	:
2	obstakelvrije zone	:	:
3	welke borden (nrs)	:	:
4	bebakeningsborden	:	:
5	bewegwijzeringsb	: aanwezig / afwezig	: aanw / afwezig
6	openbare verlicht	: hoog / laag / afwezig	: hoog / laag / afw
7	aantal rijstroken	: 1 / 2 / 3 / 4	: 1 / 2 / 3 / 4
8	fietspad aanwezig	: aanwezig / afwezig	: aanw / afwezig
9	verharding	: zoab/asfalt/beton/klinkers	: zoab/asf/beton/klink
10	bermafscheiding	: gel rail/ hek /anders/afw	: gel r/hek/and/afwez
11	kantstreep	: aanwezig / afwezig	: aanw / afwezig
12	midden afscheid.	: gel rail/berm/anders/afw	: g rail/berm/anders/afw
13	wegas	: getrokk/ onderbroken/afw	: getrokk/onderbr/afw

Bijzonderheden:

1) indien van toepassing.

omcirkel wat van toepassing is.

II

Weer : onbewolkt / 1/2 bewolkt / zw bew / regen

Type lok : BOOG

Hmp 1) : van tot / anders /

Gegevens : RIJRICHTING : ---> : <---

		--->	<---
	Foto nrs		
	negatief nrs		
1	rijbaanbreedte		
2	obstakelvrije zone		
3	welke borden (nrs)		
4	bebakeningsborden		
5	bewegwijzeringsb	aanwezig / afwezig	aanw / afwezig
6	openbare verlicht	hoog / laag / afwezig	hoog / laag / afw
7	aantal rijstroken	1 / 2 / 3 / 4	1 / 2 / 3 / 4
8	fietspad aanwezig	aanwezig / afwezig	aanw / afwezig
9	verharding	zoab/asfalt/beton/klinkers	zoab/asf/beton/klink
10	bermafscheiding	gel rail/ hek /anders/afw	gel r/hek/and/afwez
11	kantstreep	aanwezig / afwezig	aanw / afwezig
12	midden afscheid.	gel rail/berm/anders/afw	g rail/berm/anders/afw
13	wegas	getrokk/ onderbroken/afw	getrokk/onderbr/afw
14	boogstraal 2)		
15	hoekverdr/lengte 2		

Bijzonderheden:

1) indien van toepassing.

2) bij wegbeheerder opvragen.

omcirkel wat van toepassing is.

III

Weer	: onbewolkt / 1/2 bewolkt / zw bew / regen		
Type lok	: KRUISPUNT	Rona nr	:
Hmp 1)	: van tot / anders /		
Gegevens	: RIJRICHTING	: 1.	: 2.

	Foto nrs	:	:
	negatief nrs	:	:
1	rijbaanbreedte	:	:
2	obstakelvrije zone	:	:
3.a	welke borden (nrs)	:	:
3.b	welke voorr regel	:	:
4	bebakeningsborden	:	:
5	bewegwijzeringsb	: aanwezig / afwezig	: aanw / afwezig
6	openbare verlicht	: hoog / laag / afwezig	: hoog / laag / afw
7	verkeerslicht inst	: aanwezig / afwezig	: aanw / afwezig
8.a	aant rijstr rechtd	: 1 / 2 / 3	: 1 / 2 / 3
8.b	aant rijstr li-af	: 1 / 2 / afwezig	: 1 / 2 / afwezig
8.c	aant rijstr re-af	: 1 / 2 / afwezig	: 1 / 2 / afwezig
9	fietspad aanwezig	: aanwezig / afwezig	: aanw / afwezig
10	fietsp kruis.tak	: aanwezig / afwezig	: aanw / afwezig
11	verharding	: zoab/asfalt/beton/klinkers	: zoab/asf/beton/klink
12	bermafscheiding	: gel rail/ hek /anders/afw	: gel r/hek/and/afwez
13	kantstreep	: aanwezig / afwezig	: aanw / afwezig
14	midden afscheid.	: gel rail/berm/anders/afw	: g rail/berm/anders/afw
15	wegas	: getrokk/ onderbroken/afw	: getrokk/onderbr/afw

Bijzonderheden:

1) indien van toepassing.

omcirkel wat van toepassing is.