Technical note, comparison of methods

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Executive summary

This document is a technical note and summarises the findings in the SPACE project (Speed Adaption Control by Self-Explaining Roads) regarding the suggested methods to evaluate Self-explaining treatments. SPACE is a European project looking at the meaning of self-explaining roads and what types of measures that is most effective in achieving the objectives of self-explaining roads in terms of speed adaption. The work has been carried out in three major steps. The first phase was to identify promising treatments for SER that could be used in the next phase which was to evaluate some promising SER measures by the means of workshops with experts and using video and pictures as a source to trigger the discussions. The final phase was to use a driving simulator to evaluate one of these SER treatments selected through the completion of the two first phases. Our impression was that it was clear that combinations of treatments work effectively and that the selected treatment tested showed that consistency of treatment is promising in order to reduce speed in severe curves. In order to identify what treatment for SER to test in a driving simulator experiment, expert workshops, presenting identified SER treatments selected through literature seem to be a well working, stepwise process. Workshops can also be used on its own for certain evaluations. The use of workshops is particular useful in evaluation of the trans-national perspective.

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1. Introduction

"The objective of the SPACE project (funded by ERA Net Road) was to define what is meant by the term "self-explaining roads" and to investigate what treatments might be used in order to encourage drivers to adopt speeds that are safe and appropriate to conditions. The work was organized in five work packages; package 1 was the Literature review, package 2 was the Identification of Self-Explaining Treatments, package 3 was the Expert Workshops, package 4 was the Driving Simulator Study and finally package 5 Management and Reporting. The actual work to develop the evaluation tools was done in work package three and four, see Figure 1 below.

More specific the objective of the SPACE project is to identify promising SER solutions and develop tools (method) to evaluate their effectiveness, particularly in relation to their impact on speed choice on rural roads.

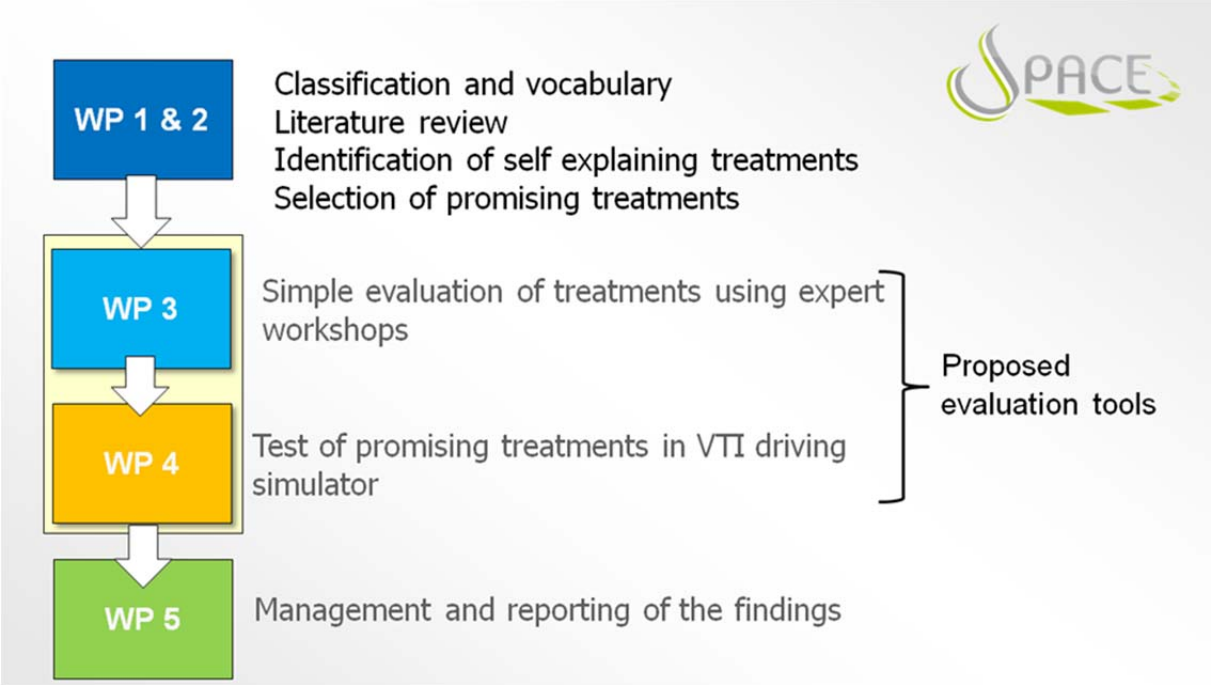

Figure 1 SPACE work flow and the five work packages

2. Background

The SPACE project focuses on treatments that influence the sensory perception and cognition of road users (not just in terms of categorisation), particularly in relation to appropriate speed choice. From the initial phase of SPACE, treatments (largely for rehabilitation/retro-fitting) that could be considered 'self-explaining' were summarised. This summary was organised according to the type of road section the treatments might be applied for:

- Curves
- Transitions
- Intersections
- Links

Measures for Curves and Transitions were decided to be investigated further. Since, at these stretches of road, speed was considered as a critical parameter.

This note reports and discusses the findings and usefulness of the methods proposed by SPACE to evaluate and assess self-explaining treatments. The detailed information on the work and outcomes of SPACE can be found in the separate deliverables D1 (*Self-Explaining Roads Literature review and Treatment Information)*, D2 (*Methods to evaluate international SER treatments, Preparations for a workshop)*, D3 (*Self Explaining Road Treatments: Report from expert workshop) and D4 (Consistent treatment in relation to the severity of a curve; a driving simulator study). The reports will be found on SPACE homepage hosted by FEHRL,* www.**fehrl**.org/**space**

3. Methods to evaluate self-explaining treatments

The SPACE idea is to initially use experts' workshops to select and evaluate a group or number of relevant self-explaining treatments to discuss their potential effectiveness (through the use of video sequences showing examples of SER Treatments). Following this the use of a driving simulator experiment was suggested to further give a quantitative assessment of the identified treatments from initial phase, see Figure 2. In the SPACE project effectiveness was focused on the treatments ability to make traffic users reduce or adapt the speed on rural roads. No accident analysis was though involved.

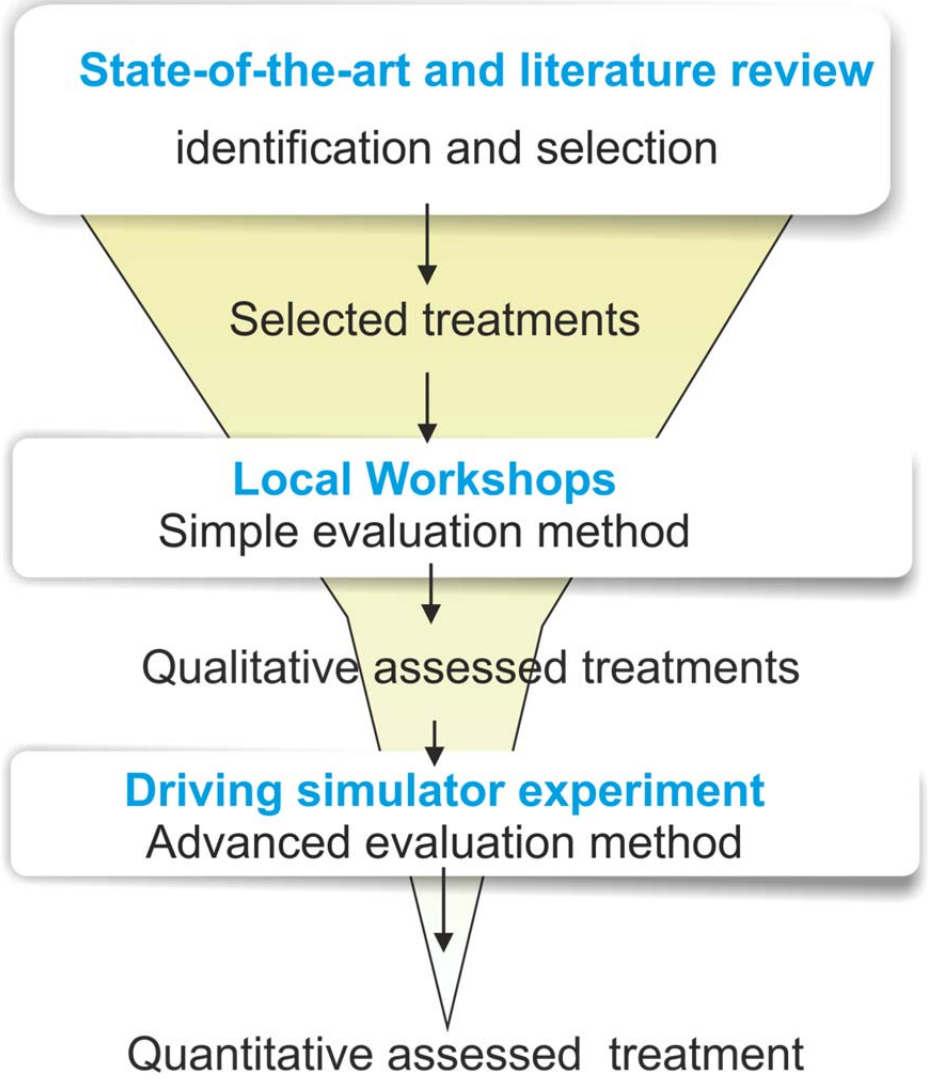

Figure 2 The SPACE evalution flow

Expert workshops

In the first step expert workshops were used. The objective of the workshops was to provide an initial evaluation of the Self Explaining Road (SER) treatments identified during the literature and expert review as having the potential to reduce vehicle speeds. The expert workshop focused on treatments to be used at *curves and transitions* since the initial phase concluded that these should offer the greatest potential for collision reduction through lower vehicle speeds.

To achieve the objective expert workshops were held in a number of different countries (Belgium, the Czech Republic, Sweden, Ireland, and Austria) using the same information material (see D2 *Methods to evaluate international SER treatments, Preparations for a workshop* and D3 *Self Explaining Road Treatments: Report from expert workshop*). Conducting the workshops in this way allowed the SPACE project to gather the opinions of many more experts (than through one international workshop) and gained a far greater insight into the treatments that were of interest. In total, there were 62 experts involved. They were from various backgrounds: regional road authorities, universities/research organisations and consultants, but also from an automobile club, a motorcycle drivers association, a Police department and a private company. Deliverable 3 provides a review of the discussion on

SER measures from these workshops. The workshops started with a discussion around the concept of the self-explaining-road. They continued with the evaluation (through a simple evaluation method making use of photos, videos to display different scenarios) of several infrastructure measures identified during the initial phase e.g. curves and transitions. An interesting debate happened during the workshops around the concept of self-explaining road. All participants agreed that a SER was one that explained itself to the driver, but while practitioners/engineers included signs, street furniture, street markings as part of a system needing to be self-explaining; the planners and academics did not agree with this point of view and felt a SER is a road where a driver instinctively knows how to drive on the road without the need for signage or other external aids.

One key finding from the expert workshop is that professionals were particularly uneasy about the notion of single treatments being applied in isolation. It may therefore be of benefit to move towards investigating the use of combinations of treatments in the driving simulator studies. One promising notion is to consistently treat bends with a hierarchy of treatments mapped closely to the severity of the curve. This has potential to offer not only scientifically interesting results but also results that can be applied directly by practitioners.

Driving simulator experiment

The second step was to use a driving simulator experiment. One part of the objectives was to create and specify details in a method to use the driving simulator experiment as a tool to evaluate and assess a selected self-explaining treatment. To use the driving simulator this way is nothing new. But the SPACE experiment confirmed assumptions such as required number of participants; time in the simulator and dependent variables to use etc. The overall aim of this work is to develop guidelines for evaluation of potential treatments, categorized as “self-explaining treatments” by the use of a driving simulator. More specific the driving simulator study had the aim:

To evaluate the effectiveness of curve treatments, in particular to determine whether a combination of treatments on curves according to their severity could help drivers correctly establishing the severity of a curve in advance and therefore adapts their speed appropriately.

In total 35 participants, divided into two groups, drove approximately 46 minutes on a rural road with 3 baseline curves without treatment and 9 curves with treatment of varying levels. In total three different treatment levels and three different curves were used. One group received treatments before each curve that correspond to the severity of the curve (slight curve – low treatment level; moderate curve – medium treatment level; severe curve – high treatment level); the other group experienced inconsistent treatments by being exposed to all nine possible combination of curve and treatments.

The analysis of the effects on average speed and at given points along the curve was carried out with Mixed Model ANOVA. Dependent variables were speed measurements at the different points along the curve and the average speed through the total curve. The analyses were done both for absolute speeds and for the relative change in speed from starting point. Independent variables were consistent/inconsistent group; curve (1-3), treatment level (1–3) and time on task, here called order (1–9). The subject was used as random and nested on group. In addition the most severe curve was analysed separately in order to compare the groups.

In conclusion the result showed that in most cases there were significant effects for treatment levels, severity of the curve, order (time on task), and for subject. There was no significant main effect for group (consistent/inconsistent). However, there was an interaction between curve and group, telling us that the consistent marking significantly reduced the average speed among those who experienced curves with consistent treatment. A final argument for

the effectiveness of consistent treatment is that if only the severe curve was considered, the group was significant.

4. Discussion and comparisons of methods

It was concluded that the SPACE concept was a working procedure to evaluate self-explaining potential treatments. Originally it was planned to have one international expert workshop. Mainly due to budget reasons and lack of time it was decided to conduct local workshops in participant's countries. As it turned out this was a successful change. By having local workshops it was found that, in the view of the trans-national perspective, much more knowledge was achieved.

In the first planning of SPACE project the trans-national perspective was discussed and suggested to be achieved through the driving simulator experiment. People from different countries, with national experience, should be tested in the simulator with the exactly same circumstances and treatment-scenarios. This idea was also rejected due to budget reasons. As a conclusion the use of national expert workshops using the same guidelines and same material (question forms and video sequences showing examples of SER treatments) was successful, especially in the view of trans-national assessment. This approach was called the "simple evaluation method".

The "simple evaluation method" as it was used at the different SPACE workshops in different European countries triggered very interesting discussions on SERs among the participants. From that we can conclude that the use of video sequences showing examples of SER treatments can be useful in eliciting the view of experts and road authorities, or used as material for workshops or training sessions.

The "simple evaluation method" may not be very effective for experimentation purposes in order to determine the effectiveness of different SER treatments. Other issues also make the method (as used in the workshop) imperfect:

- It would be preferable to present the same situation under different circumstances (night/day, dry weather/rain,…).
- The movie sequence must show the situation over distance longer distance before and after the SER treatment under evaluation – this makes it more difficult to control for other variables that might influence the behaviour under investigation.
- It is difficult to study the longer term effects of a treatment on behaviour using this methodology.

The collection of interesting material from real world implementations of SER treatments has been rather challenging. An additional tool that could be of use in future instead of video material is that of animation: by adding objects in an artificial way to a movie in order to show different (combinations of) SER treatments at a particular existing site, the different approaches can be evaluated and compared.

The simplicity of the "simple evaluation method" makes it difficult to study all aspects of user behaviour with respect to SER methods in an equally rigorous way as might have been envisaged. The driver simulator studies are without any doubt a very useful method for scientifically well-founded research and for that purpose cannot easily be replaced by a simpler method.

The experience in the SPACE project shows that the "simple evaluation method" can play a role in a preparatory phase, preceding a driver simulator study, to select what to test. The participants in the workshops generally agree that the "simple evaluation method" can also have its place for particular "project level" studies or in training sessions.

Using a driving simulator to evaluate potential SER treatments is an excellent way to

evaluate SER-treatments, as shown by the SPACE experiment. The main disadvantage is the high cost of conducting such an experiment. Another disadvantage can be that absolute speed evaluation is not recommended in driving simulator studies. In the phase of preparing a simulator experiment the scenarios has to be designed including graphical views, surroundings, treatments and other traffic etcetera. Modern driving simulator operations and experimental design include standardised graphical construction and design software making it possible to do previews. It is suggested by SPACE to take use of by using such pre- views as material to study during the workshops. This may be enough to evaluate a potential SER avoiding a full-scale driving simulator experiment. This potential should be explored more thoroughly.

It was found that our method to evaluate the effects of speed adjustment worked well. 35 participants each drove approximately 45 minutes. They were divided into a consistent and an inconsistent group. Three levels of treatments and three severities of curves were used. The dependent variable was the speed measured at three points along the curve. This methodology could be used to evaluate other types of self-explaining treatments. But since a driving simulator study requires a lot of planning and high costs it is suggested to initially conduct an expert workshop to evaluate and select the suitable SER treatment and also detailed scenario description.

5. Conclusions

In order to identify what treatment for SER to test in a driving simulator experiment, expert workshops, presenting identified SER treatments selected through literature seem to be a well working, stepwise process. The use of video sequences showing examples of SER treatments can be useful in eliciting the view of experts and road authorities during the workshops. Workshops can also be used on their own for certain evaluations. The use of workshops is particularly useful in the evaluation of the trans-national perspective. For this purpose even common questionnaires can be a good tool to use. On two of the workshops a general questionnaire regarding factors that would cause a driver to slow down and lower the speed was used. Looking at the result it was interesting to see that road width was important in both countries but not the amount of water or ponds on the surface. In Sweden this was considered important for lowering the speed but not in Austria. The use of this type of questionnaire has great potential to be useful in the European road perspective.

It is important to have written guidelines and a specified framework how the workshops should be conducted in order to be able to compare results. The guidelines and background material used for the workshop concept can be further developed. For instance it should be possible to use the same animated graphical scenarios that are developed prior to driving simulator experiments. This may enter a possibility to even evaluate future not yet built environment and SER treatments. Having this an expert group could decide whether it is necessary to continue with a driving simulator experiment or not.

6. Sources

Deliverable D1 of the SPACE project, *Self-Explaining Roads Literature review and Treatment Information,* 2011

Deliverable D2 of the SPACE project, *Methods to evaluate international SER treatments, Preparations for a workshop*, 2011

Deliverable D3 of the SPACE project, *Self Explaining Road Treatments: Report from expert workshop*, 2011

Deliverable D4 of the SPACE project, *Consistent treatment in relation to the severity of a curve; a driving simulator study*, 2011

Web page of the SPACE project: http:www.fehrl.org/space