SIXTH FRAMEWORK PROGRAMME
PRIORITY 1.6. Sustainable Development, Global Change and Ecosystem
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Title	**Testing approach for bilingual Variable Message Signs**
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Summary	According to the TROPIC Final Report bilingual messages can reduce drivers´ ability to recall the message in their own language. Messages of less than 6 units of text can well be recalled later, whereby it does not make a difference if bilingual messages are displayed consecutively or simultaneously. It seems to be acceptable to display bilingual messages by turns of two seconds each, whereby the most comprehensible message style seems to be text with a pictogram element.
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Overview

1 Introduction

Bilingual message signs are becoming more and more important throughout the roads of a Europe growing together. People are traveling more intensively through foreign countries than ever before. Modern technology makes it easy to introduce bilingual variable message signs. The following paper describes the recent findings in the research concerning bilingual variable message signs. A testing approach for further studies regarding the comprehensibility of bilingual variable message signs is proposed. The final goal is to establish message signs in Europe which can be understood by anyone. This is part of what we like to call "Europaism".

2 Results of studies regarding the comprehensibility of bilingual variable message signs (VMS)

Karhunen [1] evaluated bilingual VMS in Finnish and Swedish. Every message could be seen for 2 seconds each. The signs are empty for half a second between the messages. The results showed that drivers in general consider the display time of 2 seconds as being long enough. Additionally, 75% of the sample recalled and accepted the message signs. Concerning the cognitive demand, there is no difference between displaying variable message signs alternatively compared to displaying them simultaneously. Nonetheless, elderly drivers consider VMS as more demanding than regular static message signs.

The TROPIC FINAL REPORT [2] yielded results about message signs with or without redundant pictograms and translations. Bilingual messages can reduce drivers´ ability to recall the message in their own language. Thus, messages should consist of less than 6 units of text if the displayed information is supposed to be recalled later. Regarding visual distraction, it does not make a difference if bilingual messages are displayed consecutively or simultaneously. So finally, it is acceptable to display bilingual messages by turns of two seconds each. Redundant pictograms seem to be useful, because the most comprehensible message style is text with a pictogram effect element.

Jamson, Tate & Jamson [3] evaluated the effect of various bilingual VMS configurations on driver behavior. Results showed that both mono- and bilingual drivers can read (mono- and bilingual) messages signs with no compensatory effects in their mean vehicle speed. But four-line bilingual message signs led to a decrease in mean speed. Different arrangements of signs, in this case the sequencing of signs, had no impact on factors associated with driving performance. Further investigations tackled the question of an additional separation line between the two used languages. But such a line made no difference with regard to driver performance. Finally, a four-line bilingual VMS with two lines of text in each language seems to be the best solution, because it can be read by mono- and bilingual drivers as good as a monolingual two-line sign.

In another study conducted by Jamson et al. [4], four-line bilingual VMS and especially four-line monolingual VMS led to a decreased mean vehicle speed, which indicates an increase of the time needed to read the sign. But still four-line bilingual VMS with two lines of text in each language are read almost in the same manner by both mono- and bilingual drivers as two-line monolingual signs.

The last study from Jamson et al. [5] to be mentioned in this paper yielded the following result: Drivers significantly reduce their vehicle speed and increase their headway in front of a leading vehicle in order to read four-line monolingual and four-line bilingual message signs. This implies that they are also reading the irrelevant text on the bilingual VMS. The reading of one- and two-line monolingual signs and two-line bilingual signs led to no disruption in their driving behavior.

Clark [6] conducted a study in which the message text was presented in turns of four seconds each in English and French. English speakers found the mono- and bilingual formats equally easy to read, the results from the drivers with French as the first language varied. The best results were obtained using a four-line display with two lines for both languages each.

Anttila, Luoma & Rämä [7] recorded the eye movement behavior of their subjects while driving. This makes the comparison of the visual demand imposed by different VMS configurations possible. The data shows that a VMS displaying alternating bilingual messages is no more visually demanding than a VMS displaying the same messages simultaneously.

The cited studies regarding bilingual VMS lead to the following conclusions:
- It is no more demanding to display variable message signs alternatively than to display them simultaneously
- Elderly drivers consider VMS as more demanding
- Messages should consist of less than 6 units of text if the displayed information is supposed to be recalled
- Four-line bilingual VMS, comprising two lines of text in each language displayed in turns, have been tested and validated as the most acceptable solution

3 Testing approach

3.1 Stimulus

Further studies concerned with the evaluation of bilingual VMS should contain at least a few of the following factors: First of all, there need to be several to be tested messages (e.g. "traffic congestion ahead", "fog warning"). The impact of redundant pictograms pertaining to the messages is also a crucial factor. The message sign can be equipped with an additional pictogram or not. Different pictograms for one message can be used to find the most appropriate one. A comparison of VMS with different contents is also useful. E.g., danger, mandatory and direction signs can be compared. Danger signs, e.g., refer to construction sites, the well known "STOP sign" is an example for a mandatory sign and a direction sign can display the name of a town or other places. Because direction signs have been subject to investigation for quite a long time, the attention should be focused on the first two ones. A distinction needs to be made between VMS along the roadside and VMS displayed overhead. The latter one has not been taken into account yet, thus a special focus must be placed on it. Especially in the case of overhead VMS, the arrangement of verbal message and pictogram can be versatile. It is possible to place the verbal message left of, right of, above, under or even inside the pictogram. The effect of such arrangements is worth of being investigated. Mono- and bilingual message signs might be shown to evaluate the effect of this factor. Thus either the native language or the native plus a foreign language is displayed. The number of lines or the number of lines per language respectively is also a matter of interest. To go more into detail, the number of characters used for a verbal message is of even more interest than the number of lines. Maybe rather the latter than the former factor is worth of being subject of further studies. The presentation sequence, although already well investigated, can also be implemented. The presentation sequence refers to both languages being presented simultaneously or consecutively. The presentation duration of the message text in one language should be varied to determine the best time interval of presentation. The time interval between the presentations is also a factor of interest, although it depends largely on the average vehicle speed and the distance between the VMS on the road. If an appropriate speaker system and synthesized voice output of verbal text messages is also at hand, its impact compared to conventional message signs is also of interest.

3.2 Sample

The sample to be used for further testing must have an appropriate sample size, preferably more than 30 subjects in a time-demanding and elaborated study, more than 80 when interviewing people passing a test track by chance. Sample size will most likely depend on budget and time available, but should be the bigger the more heterogeneous the target population is. To draw conclusions about the affected population, data about the target user group needs to be taken into account. A randomized sample drawn from the user population represents the best solution but is hard to realize, thus a convenience sample is a realistic choice. But still a balanced subjects poll taking into account variables such as age, gender and driving experience is strongly advised. The sample should also contain elderly people and non-native speaking tourists, to be able to generalize the results also to these populations.

3.3 Experimental setting

All European countries or at least several should be taken into account establishing a test track.(see pilot sites) The preferred way is to choose the countries randomly, although main transit countries are the best choice. Thereby roads connecting countries with different native languages are especially important. Every single variable message sign should be shown at least twice on the test track. The distance between VMS on the test track is advised to average at least 500 meter at a vehicle speed of about 100 km/h.
The length of the test track is calculated as follows: 500 meter multiplied by the number of VMS to be deployed. The test track can be either a real road, in this case preferably a highway, or a simulated road in a driving simulation.

3.4 Methods of data acquisition

Questionnaires need to be used to gather the important data needed for the evaluation of different message sign configurations. Online questionnaires, CAPI (= Computer Aided Personal Interviewing), personal interviews and of course conventional paper and pencil questionnaires can be used to apply the same structured questionnaire. They should be applied to question both enlisted subjects and people traveling along the test track by chance.

The following lines describe the important concepts and how to test them:

The comprehensibility of a message sign compromises the meaning of a signal, e.g. "What do you think this signal means?" and also how the population understands it, e.g. "The signal is supposed to mean (...). Please tell the percentage of the population that you expect would understand this meaning?" The level of confidence in the reliability of VMS can be assessed by asking "How reliable are variable message signs in your opinion?" The assessment of appropriate response can e.g. be done as follows: "What action would you take in response to this signal?" A very important concept is the workload and the (visual) distraction caused by a message sign, e.g. "How distracting is the shown message sign/signal?" The assessment of clearness and distinguishability of a message sign refers to the question if certain features improve or worsen them. The message can be presented in one or two languages, simultaneously or consecutively, with or without pictogram. E.g., the subjects can be asked: "How does the presence/absence of [enter feature] influence the clearness/distinguishability of a message sign?" A general acceptance rating can be done with bipolar items, such as good vs. poor, acceptable vs. unacceptable etc. The acceptance of the population should also be measured, e.g. "Estimate the percentage of the population you expect would feel annoyance, surprise or discomfort to the signal".

In addition to a structured questionnaire assessing the aforementioned concepts, pros, cons and suggestions for improvements mentioned by the subjects have also to be taken into account.

Furthermore, performance data obtained through a test vehicle or driving simulator will also be useful. Variables like mean vehicle speed, speed variation, headway to a leading vehicle and lane keeping are very important. Not to forget the possibility to measure the subjects´ eye movement and thus assessing the amount of visual distraction caused by VMS. Performance data such as bad lane keeping or a high speed variation can indicate an increased mental workload imposed by VMS.

4 References

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