



SIXTH FRAMEWORK PROGRAMME
PRIORITY 1.6. Sustainable Development, Global Change and Ecosystem
1.6.2: Sustainable Surface Transport



506716

Title	Results of the Test of Content Structure of Pictorial and Verbal Messages on VMS conducted in Austria and Czech Republic
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Summary	The test on Content Structure was conducted in two European countries. This test was performed as a flash-based animation, simulating a journey. 281 participants took part. 44 combinations of pictograms were evaluated. 28 combinations scored higher than the required score of 66.
Status	Final
Date	20.12.2007
Revisions	
Distribution	PU
Document ID	InSafety_CST_Report_FINAL
Attachments	

List of Abbreviations

CAT	Comprehension Test on Animated Pictograms
2 nd CT	2 nd Comprehension Test
CDV	Centrum dopravného výzkumu
CJT	Comprehensibility Judgement Test
CT	Comprehension Test
DUK	Danube University Krems
IIID	International Institute for Information Design
In-Safety	Infrastructure and Safety
ISO (9186)	ISO Standard 9186: „Test methods for judged comprehensibility and for comprehension”
ITS	Intelligent Transport Systems
VMS	Variable Message Sign(s)

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Participating Bodies / Credits

This test was carried out under the Sixth Framework Programme of the European Commission, within the Project "InSafety", Activity A2.2 "Pictograms substituting verbal messages on VMS".

Submitting party, Leader of Work Package 2 and Activity A2.2:

International Institute for Information Design (IIID), Vienna, Austria

Leader of Testing Activities, Testing Partner and Analysis:

Danube University Krems (DUK), Austria

Testing Partner:

Centrum dopravního výzkumu (CDV), Brno, Czech Republic

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1. Introduction

The IN-SAFETY Project focuses on the prerequisites for a successful implementation of Intelligent Transport Systems (ITS) in order to enhance the self-explanatory nature of roads.

European drivers have to cope with increasingly complex traffic environments, including vertical and horizontal signing; which is often supported by Telematics. Thus, there is a high need for a self-explanatory road environment at a personalized level which would offer intuitive guidance to the driver and information when this is needed. The information given should be related to the driver's particular needs (route, disabilities, preferences, etc). A self-explanatory road will protect the driver from making errors and will enhance his/her comfort.

Due to the fact that information displayed on Variable Message Signs (VMS) is usually shown in the local language, the complexity of information is confusing and leads to driver mistakes and safety risks. The objective of this activity within work package 2 is to increase the self-explaining road environments by presenting a proposal of homogenized and comprehensive pictograms to substitute verbal messages on VMS.

2. Method

2.1. Test procedure

The defined stages for the development and testing procedure of pictograms recommended within the final IN-SAFETY proposal are:

- 1) Collection of information needed concerning the standardization of graphical symbols and the technical requirements of VMS.
- 2) Collection of a set of existing and proposed variants for each referent/meaning.
- 3) Comprehensibility Judgement Test, according to ISO 9186, to eliminate incomprehensible solutions at an early stage: The Comprehensibility Judgement Test was conducted in April 2006, in four European countries, for 33 referents a total of 243 variants were tested by a total of 825 respondents. 56 variants have been taken into account for further testing, several variants were proposed for redesign.¹
- 4) The Comprehension Test (CT), according to ISO 9186, was conducted in three European countries, and performed as a Paper and Pencil Test. 84 variants of 33 referents had been tested and evaluated by 604 participants. 20 of the referents reached the ISO score of 66 and were recommended for the final proposal.² 11 variants were proposed for redesign and retesting.

¹ See: Brugger Ch. (2006): Comprehensibility Judgement Test; Report In-Safety, 506716. 30/04/2006.

² See: Siebenhandl K., Brugger Ch., Simlinger P., Egger S., Hollo P., Weinberger J., Vasek J. (2007): Results of the Comprehension Tests on pictograms conducted in Austria, the Czech Republic and Hungary; Report In-Safety, 506716. 05/01/2007.

- 5) The outcomes of the 2nd Comprehension Test (2nd CT), concerning the retesting of 16 variants were addressed within an additional paper. The 2nd CT was conducted in two countries, and was performed as a Paper and Pencil Test. 16 variants of 12 referents had been retested after redesign following the recommendations of the 1st CT. This test was answered by 307 participants. Eight referents reached the required ISO score of 66.³
- 6) Checking comprehensibility of variants under conditions of impaired vision.
- 7) The comprehensibility of animated pictograms was tested separately. The Comprehension Test on animated pictograms (CAT) was conducted in 2 countries, performed as flash-based animation. 18 variants of 10 referents had been tested and evaluated by 308 participants. The test results were compared to the results of static pictograms.⁴ 3 referents scored higher than 66 ISO Score, the picture content of these pictograms is approved.
- 8) The content structure of pictorial and verbal messages on VMS is addressed within this report. The comprehensibility of the proposed variants is evaluated and compared focussing on their cognitive value and compared to the results of the CT and the CAT.
- 9) Acceptance as a standard graphical symbol, which has been evaluated the most comprehensible and surpasses the criterion of acceptability.

The evaluation criteria and methods for testing follow the ISO 9186 "Test methods for judged comprehensibility and for comprehension"⁵. Details on applying the CT can be found in this standard.

2.2. Aim of the test

Special attention was drawn on the comprehensibility of the given combined information and can be summarized by the following leading questions:

- Is the structure of the content comprehensible and understandable?
- Are the pictograms shown together comprehensible and understandable?
- Is there an information overload?

³ See: Siebenhandl K., Brugger Ch., Simlinger P., Egger S., Weinberger J. (2007): Results of the 2nd Comprehension Test on pictograms conducted in Austria and the Czech Republic; Report InSafety, 506716. 24/08/2007.

⁴ Siebenhandl K., Brugger Ch., Simlinger P., Egger S., Hollo P., Weinberger J., Vasek J. (2007): Results of the Comprehension Test on animated pictograms conducted in Austria and the Czech Republic; Report In-Safety, 506716. 24/08/2007.

⁵ ISO, International Standardization Organization (2001): ISO 9186, Graphical symbols – Test methods for judged comprehensibility and for comprehension. Geneva: ISO.

2.3. Test Setting

The test setting was based on an animated simulation; the test series were driven by a pre-programmed flash-movie. Upfront, the participants were given a verbal instruction, telling them that they should imagine driving along a highway and that pictograms will appear. The test structure reconstructed a simulated journey on a motorway, having a starting point, one intermediate stop, and an endpoint. Pictograms shown within this journey were related to these points.

Test persons were seated in front of a screen projection to simulate a driving situation. The distance to the screen (viewing distance) and the size of the presented pictogram were carefully balanced. The chosen pictogram size was aimed to allow for the discrimination of small graphical detail.

Each (animated) pictogram was shown for exactly 3.3 seconds⁶, which is the time from the first clear comprehension of the pictogram to the moment of its disappearance at a velocity of 100 km/h.

After presenting each combination of pictograms the participants were asked what symbols had been presented and what reactions they would take in response to them. The test duration was about 15 minutes.

The basic conditions of the test setting are shown in figure 1:

Physical settings

Projection area (AxB): 213cm x 165cm

Distance projection area – floor (C): 194 cm

Viewing distance (D): 255,6cm

Technical Settings

Projector resolution 1024x768

PC Screen resolution 1024x768

⁶ One exception: The pictograms A9 (switch off engine) and B48 (switch off engine) were shown for 20 seconds, as they simulate a congestion.

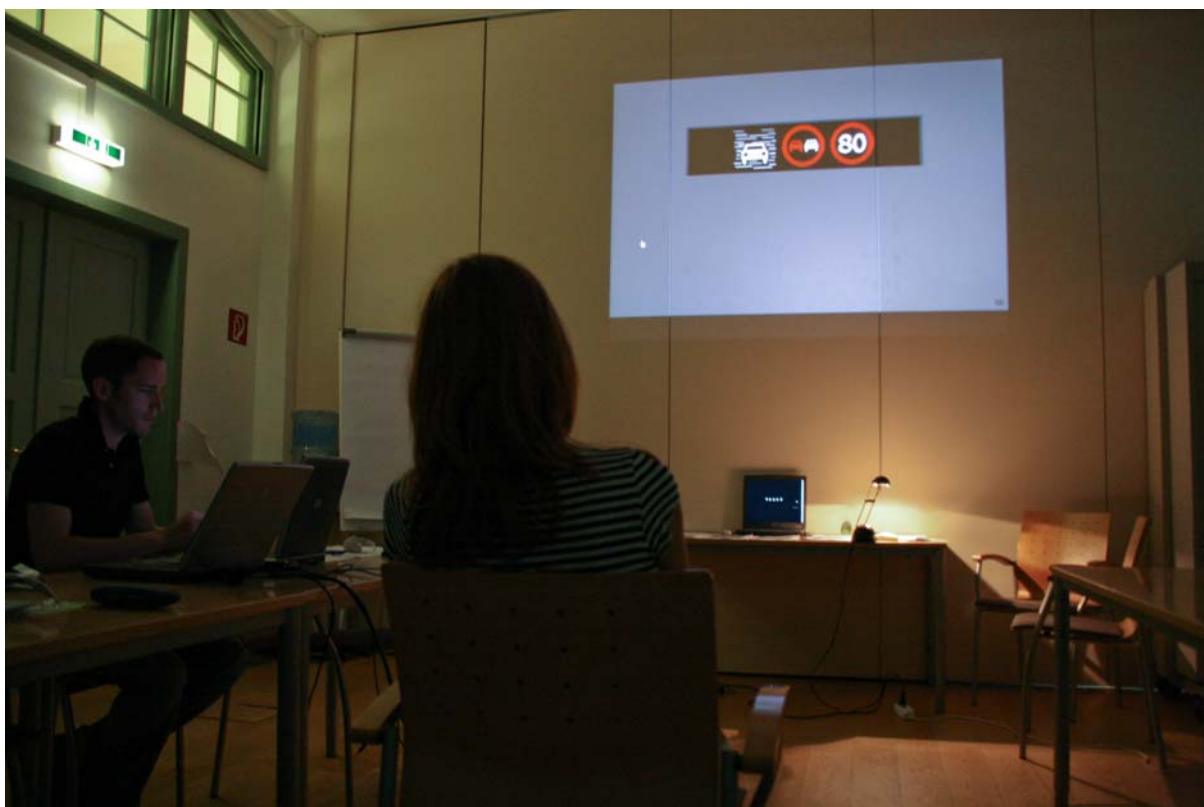













Figure 1: Physical settings for the Test of Content Structure of pictorial and verbal messages on VMS, source: authors

2.4. Referents

Within the test on content structure two or more referents were combined to one “picture”. Overall 45 of these pictures were tested. They were split into three different series in order to ensure reliable testing. One series contained 15 pictures. Table 1 shows the assignment to the series.

Table 1: Assignment for the analysis




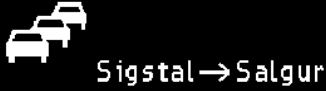










Assignment Nr.	Ref Nr.		Ref Nr.		Ref Nr.		Ref Nr.	
1	A37		B38		C39			
2	A11							
3	B17		B18		C19		C20	
4	C13		B15		C14			
5	A21							
6	C40							
7	B41		A43					
8	A46		B47					
9	A16		B29		C36			
10	A6		B7		C8			
11	A1		B2					
12	A4		C5					
13	A3		B10		C24			
14	A28		B27		C25			

15	A22		B49		C26			
16	A34		B35		C33			
17	A9		B48					
18	A45							
19	C30							
20	C42							
















2.4.1. Assignment and Instruction for Series A

Instruction for the participants	Ref. Nr.	
Travelling from the country to the city: You plan to go on a journey to a distant capital city called Mels. Along the way, two stops are planned at Sonbor, and Galno.		
You start your journey to the first destination Sonbor to go skiing.	37	
	21	
	6	
	1	
You arrive at Sonbor and stay overnight. On the next day, you continue your journey to Galno.	16	
	3	
You stop at Galno for a break, then you continue your trip to Mels.	11	
	4	
	28	
	22	
You are approaching Mels, the capital city.	43	
	34	
You are within a congestion queue on the main route into Mels. You are a member of the ADAC automobile club.	9	
You want to leave the motorway to find a public transport to travel into the centre of Mels.	45	
	46	

2.4.2. Assignment and Instruction for Series B

Instructions for the participants	No.	
Going from the city on a skiing holiday You plan to go on a journey into the mountains for a skiing holiday at Sonbor. Along the way, a stop at Galno is planned.		
You start your journey in the city to the first destination, Galno.	41	
You are driving on the left lane but want to change the motorway.	47	
	29	
	27	
	49	
You are within a congestion queue. You are a member of the ADAC automobile club.	48	
	15	
	38	
	35	
	18	
	17	
	10	
You arrive at Galno. The next day you continue your journey to your skiing holiday at Sonbor.	7	
	2	

2.4.3. Assignment and Instruction for Series C

Instructions for the participants	No.	
<p>Travelling to a football match You plan to go on a journey to a Champions League football match. Along the way, stops at Galno and Mels are planned.</p>		
<p>You start your journey to the first destination Galno.</p>	<p>14</p>	
	<p>13</p>	
	<p>20</p>	
	<p>30</p>	
	<p>19</p>	
	<p>8</p>	
	<p>40</p>	
	<p>24</p>	
<p>You arrive at Galno. On the next day, you continue your journey to Mels.</p>	<p>39</p>	
	<p>5</p>	
<p>You stop at Mels to have a break. Then you continue your journey to the Champions League football match.</p>	<p>36</p>	
	<p>25</p>	
	<p>26</p>	
	<p>33</p>	
	<p>42</p>	

2.5. Testing

Each participating organisation (Danube University Krems and Centrum dopravního výzkumu (CDV)) conducted the test with at least 50 respondents for each series, in total 150 respondents (per organisation) were invited.

The test-leaders were informed that the sample of respondents should resemble the eventual user population in terms of age, sex, and educational level. Persons with severe visual impairment (no correction possible) were not allowed to take part. The sample should preferably consist of respondents who were expected to be familiar with the referents. Therefore, only participants who hold a driving licence were recruited for this test.

The test was conducted by supervisors, who gave the participants a verbal instruction first, detailing the “simulated” journey in terms of stops and places to go. To concretize the situation of the journey, participants were given a route planner naming the cities and telling them that they are members of the ADAC automobile club. There was also an explanation of the “Rerouting arrow” which was not used before and is not usual in Middle-Europe⁷. Additionally, each animation contained a small written introduction:

“We are studying the comprehensibility of symbols used on highways.

A series: You are travelling from the country to the city

You plan to go on a journey to a distant capital city called Mels. Along the way, two stops are planned at Sonbor and Galno.

B Series: You are going from the city on a skiing holiday

You plan to go on a journey into the mountains for a skiing holiday at Sonbor, along the way a stop at Galno is planned.

C Series: You are travelling to a football match

You plan to go on a journey to a Champions League football match. Along the way, stops at Galno and Mels are planned.

⁷ The given route planners for the series A-B-C as well as the example of the rerouting arrow can be found at the annex of this report.

You will see different combinations of signs during your journey, after each shown sign, you are asked what you think the symbol means and what action you would take in response to it.”

Overall 15 pictures had to be evaluated by each participant. After each shown picture the participants were asked what they think the symbols mean and what actions they would take in response to them.

2.6. Participants

A total of two countries (Austria, Czech Republic) participated in the test, with 119 participants in Austria and 162 participants in the Czech Republic. Overall 281 respondents (176 male, 105 female) took part in the test.

Due to the high amount of male participants within the Czech test series, gender equality was not reached within that test series. But overall a resemblance of the test sample with the driver population in terms of age, educational level, and driving experience was achieved. Detailed sample characteristics are shown in table 2.

Table 2: Respondents Statistics of the Test Series

	Austria	Czech Republic	Total	Total Means and Values	
Respondents	119	162	281		
Average age (in years)	30	37,15	33,58		
Gender					
Men	55	121	176	63%	
Women	64	41	105	37%	
Educational Level					
Primary	12	39	51	18%	
Secondary	72	101	173	62%	
University	34	22	56	20%	
Unknown	1	0	1	0%	
Driving Experience					
Average distance (km)/year	6.366,36	28.925,00	17.645,68	17.645,68	Average
Years	11,6	16,95	14,28	14,28	Average

2.7. Analysis

The analysis of the results of the Test of Content Structure of Pictorial and Verbal Messages on VMS followed the approved evaluation of the ISO Standard 9186 “Test methods for judged comprehensibility and for comprehension”⁸.

The analysis involved three independently working judges, who assigned each response to one of the following seven standard categories:

- Cat.1.: Correct understanding of the symbol is certain
(Estimated probability of correct understanding over 80%)
- Cat.2.: Correct understanding of the symbol is very probable
(Estimated probability of correct understanding between 66 and 80%)
- Cat.3.: Correct understanding of the symbol is probable
(Estimated probability of correct understanding between 50 and 65%)
- Cat.4.: The meaning which is stated is the opposite of that intended
- Cat.5.: Any other response
- Cat.6.: The response given is “Don’t know”
- Cat.7.: No response is given

An overall score for each variant is obtained by weighing and summing the percentages of responses in the different categories. The variant with the highest overall score is the most comprehensible variant.

As there is no further specific score determination within the current ISO Standard, the analysis on the results follows the criteria according to ISO 9186 (first edition 1989)⁹, which provides the following evaluation scheme:

“If the comprehension score for this variant exceeds 66, then this variant may be used to define the standard image content.

Where two variants have the same comprehension score, the most comprehensible variant can be identified by taking the one having the lowest percentage of responses in category 5 (“the response is wrong”).

For critical referents (e.g. safety symbols) the 66 criterion shall be rigorously adhered to.




For less important referents the criterion may be relaxed by including category 3 responses in the cumulative value in order to comply with the 66 criterion”

⁸ ISO, International Standardization Organization (2001): ISO 9186, Graphical symbols – Test methods for judged comprehensibility and for comprehension. Geneva: ISO.

⁹ ISO, International Standardization Organization (1989): ISO 9186: First Edition, Procedures for the development and testing of public information symbols. Geneva: ISO.

3. Answers on the Test of Content Structure of Pictorial and Verbal Messages on VMS

1. Deer on the road

Ref. Nr.	VMS Content example
A 37	Speed limitation left / deer on the right hand side, facing left 
B 38	Deer on the left hand side, facing left / speed limitation to the right 
C 39	Deer on the left hand side, facing right / speed limitation to the right 

Variant	A 37			B 38			C 39		
Austria									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	40	100	100	41	93,2	89,1	29	96,7	87,9
Very probable	0	0	0	2	4,5	3,3	0	0	0
Probable	0	0	0	1	2,3	1,1	1	3,3	1,5
Opp. meaning									
Wrong									
Don't know									
No response									
Total	40	100	100	44	100	93,5	30	100	89,4
Czech Republic									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	38	73,08	73,08	51	85	85	25	50	50
Very probable	9	17,31	12,98	3	5	3,75	13	26	19,5
Probable	5	9,62	4,81	6	10	5	12	24	12
Opp. meaning	0	0	0	0	0	0	0	0	0
Wrong	0								
Don't know									
No response									
Total	52		90,9	60		93,75	50		81,5
Overall score		A	95,5		B	93,63		C	85,45

Most frequent responses	A 37	B 38	C 39
Category 1	Speed limit 80, deer on the road	Speed limit 80	Speed limit 80
	Deer on the road, reduce speed to 80	Deer on the road	Deer on the road
Category 2	Speed limit, danger	Speed limit 80	Reduce speed, 80
		Deer on the road, reduce speed	
Category 3	Careful, deer pass	Deer pass	Slowly, deer pass

All three variants showed the sign of “Deer on the Road” together with the speed limitation of 80 km/h. They scored up from 85,45 (Variant C) to 95,5 (Variant A).

In general participants repeated the information given from the left to the right side in reading order. In Austria, 40 answers for referent A37 were given within category 1, all of them include the speed limitation and the explanation of “Deer on the road”. 28 answers mention the term “80km/h” first. In contrast, for referent B38 25 out of 41 answers categorized within category 1 stress the term “deer on the road” first.

All three variants worked well, picture content is approved.

2. Flooded road





Ref. Nr.	VMS Content example
A 11	Flooded road / speed limit 80 kph 

Variant	A 11		
Austria			
Category	f	%	Score
Certain	29	72,5	72,5
Very probable	7	17,5	13,1
Probable	0	0	0
Opp. meaning	0	0	0
Wrong	5		
Don't know			
No response			
Total	41		85,63
Czech Republic			
Category	f	%	Score
Certain	36	66,67	66,67
Very probable	11	20,37	15,28
Probable	5	9,26	4,63
Opp. meaning	0	0	0
Wrong	1		
Don't know	0		
No response	1		
Total	54		86,57
Overall score		A	86,1

Most frequent responses	A 11
Category 1	Flooded road, 80 Aquaplaning, 80
Category 2	80, drive carefully Water on the road Aquaplaning
Category 3	Slow down
Category 5	Road surface damaged Street is dirty Muddy road

This sign indicated the referent of „Flooded road“ in combination with a speed limitation. Flooded road had been tested within the CT as well and reached a score of 73,9. Showing the context of this pictogram increased the ISO Score to 86,1. The picture content is approved and is recommended.

3. Combinations of “Freezing Fog”

Variant	VMS Content example
Freezing fog / 60	
B 17	Freezing fog, speed limit 60 kph 
Freezing fog in 3 km / 100	
B 18	Freezing fog (reduced size), in 3 km (small font size), speed limit 100 kph 
Freezing fog in 3 km / 100	
C 19	Freezing fog, in 3 km (medium font size), speed limit 100 kph 
Freezing fog / Road surface temperature	
C 20	Freezing fog, road surface temperature minus 5 °C 

Variant	B 17			B 18			C 19			C 20		
Austria												
Category	f	%	Score	f	%	Score	f	%	Score	f	%	Score
Certain	23	51,1	50	19	41,3	41,3	22	66,7	66,7	5	15,62	15,62
Very probable	15	33,3	24,5	10	21,7	16,3	5	15,2	11,4	21	65,62	49,21
Probable	3	6,7	3,3	17	37,0	18,5	5	15,2	7,6	4	12,5	6,25
Opp. meaning	0	0	0	0	0,0	0,0	0	0,0	0,0	1	3,12	-3,12
Wrong	4	8,9	0	0			1			1		
Don't know	0	0	0	0			0					
No response												
Total	45	100	77,7	46	100	76,1	33	100	85,6	32	100	67,97
Czech Republic												
Category	f	%	Score	f	%	Score	f	%	Score	f	%	Score
Certain	44	73,33	73,33	20	33,33	33,33	17	34	34	3	6	6
Very probable	10	16,67	12,50	19	31,67	23,75	19	38	28,5	30	60	45
Probable	6	10	5	20	33,33	16,67	12	24	12	15	30	15
Opp. meaning	0	0	0	0	0	0	0	0	0	0	0	0
Wrong							1			2		
Don't know												
No response				1			1					
Total	60	0	90,8	60		73,75	50		74,5	50		66
Overall score	105	B	84,25	106	B	74,93	83	C	80,05	82	C	66,98




Most frequent responses	B17	B18	C19	C20
Category 1	Speed limit 60, snow and ice on the road	Danger of skidding the next 3 km , speed limit 100km/h	Freezing Fog, attention, 100 km/h, within the next 3 km	ice on the road surface, danger of skidding, temperature of the road surface -5 degree
		In the stage of 3km danger of skidding, speed limit 100 km/h	Attention glazed frost, 100 km/h, next 3 km	Snowfall, danger of skidding, temperature of the road surface
		Black ice in the stage of 3km, speed limit 100km/h	snowfall and fog danger of skidding, speed limit 100km/h	Temperature of road surface -5, danger of skidding
				Slippery road surface, temperature -5
Category 2	Danger of snow and ice, reduce speed	Black ice in the stage of 3km, speed limit	In the stage of 3km danger black ice, slippery road	Black ice creation, danger of skidding
	Reduce speed to 60	Snow or black ice, danger of skidding, speed limit	Black ice, slippery road, speed limit 100km/h	Danger of skidding on the icy road
		Stick fog, snowfall, ice accretion, speed limit 100km/h	Freezing fog, speed limit 100km/h	Road surface temperature -5°C
		Slippery road, danger of skidding, speed limit 100km/h	Black ice, speed limit	
Category 3	Danger of accidents, reduce speed	Black ice in the stage of 3km, speed limit 80km/h	Slippery Road	Danger of skidding
	Attention of road surface, speed limit	Slippery road in the stage of 3km, snowfall, speed limit 80km/h	Speed limit, 100km/h	Impaired driving conditions
		Danger of skidding, speed reduction	Take care of glazed frost	Attention, black ice
		Danger of skidding in the stage of 3km, snowfall, speed limit 80km/h	Speed limit 80 km/h	
Category 4		-		Danger of black ice over, drive on normally
Category 5		-	Attention, dangerous road, 3km	Danger of skidding, information about exit on the right lane, reduce speed
				Danger of skidding in the stage of 3km, recommended speed

These four signs depicted the referent of „Freezing fog” in combination with a speed limitation. Variant C20 included also the road surface temperature.

Variant B17 was scored best (84,25) followed by C19, whereas B18 and C 20 reached scores around 70. In comparison to the CT, where the referent “Freezing fog” was tested with a score of 71,3, the score was improved within all variants by showing the context (“Skiing holiday”).

Variant B18 reached a score of 74,93, whereas variant C19 received a higher score of 80,05, showing the 3km distance in a medium font size. Answers for variant B include significantly more often the speed limit of 80km/h, whereas a speed limitation of 100km/h was shown. (12 answers in the Austrian group, 14 answers within the Czech group). These answers were categorized within the category “probable”. For variant C this phenomenon was not noticed.

4. Variations of Fog

Ref. Nr.	VMS Content example
Fog / 80	
C 13	Fog, speed limit 80 kph 
Fog in 3 km	
B 15	Fog, in 3 km (medium font size) 
Fog in 3 km	
C 14	Fog (reduced size), in 3 km (small font size) 

Variant	C13			B15			C14		
Austria									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	7	21,88	21,88	18	40,0	40,0	4	12,1	12,1
Very probable	2	6,25	4,69	3	6,7	4,9	2	6,1	4,5
Probable	15	46,88	23,44	4	8,9	4,3	3	9,1	4,5
Opp. meaning		0,00	0,00						
Wrong	8			18			19		
Don't know				2			5		
No response									
Total	32		50	45		49,2	33		21,2
Czech									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	11	22	22	27	45,0	45,0	10	20	20
Very probable	18	36	27	24	40,0	30,0	15	30	22,5
Probable	14	28	14	2	3,33	1,67	3	6	3
Opp. meaning	0	0	0	0	0,00	0,00		0	0
Wrong	7			6			21		
Don't know				1					
No response				27	45,0	45,0	1		
Total	50		63	60		76,7	50		45,5
Score	82	C	62	105	B	62,95	83	C	33,35

Most frequent responses	B 15	C 13	C 14
Category 1	Fog, speed limit 80	Attention fog in the stage of 3km	Fog in 3 km distance
	Warning of fog, 80	impaired visibility, 3km, drive slowly	
		Fog within the next 3 km	Fog within the next 3 km
Category 2	Poor visibility, reduce speed, 80	Fog in 3 km distance	Impaired visibility
	Drive carefully, fog	Impaired visibility	
		Reduce speed because of impaired visibility	Reduce speed because of impaired visibility
Category 3	Reduce speed 80	3km, warning sign	3km, warning sign
	Danger, reduce speed	Fog in 3 km distance	
	Attention (blinking warning element), 80	Attention, warning within 3 km	
	Blinking warning element		
Category 4			
Category 5	Congestion ahead	3 km congestion	Attention within the next 3 km congestion, reduce speed
	Oncoming illegal traffic ahead	Aquaplaning, Ice on the road, water on the road	Car with a red rectangle
		Attention, wrong way driver	Oncoming illegal traffic, 3 km
	Danger, warning drive 100, blinking element,	Oncoming illegal traffic	Congestion, 3 km

Variant C13 showed static version of “Fog” flashed with a blinking warning element together with the speed limitation. Variant B15 showed an animated version of “fog” combined with the distinction of 3km/h. Variant C14 depicted the distinction of 3 km/h in small font size combined with static version of “Fog” flashed with a blinking warning element.

The static referent “Fog” was tested within the CT, where it scored highest with 80,8, and as an animated version within the CAT, where it scored 58,4. Within these test series, variants C13 and B15 scored slightly over 60, the results are comparable to those of the CAT.

The analysis of the given answers shows that the blinking warning element used within variants C13 and C14 leads more often to the assumption of “Danger ahead”, testing persons often mention the description of “Oncoming illegal traffic”.

The static version of this referent was comprehended better.

5. Snow

Ref. Nr.	VMS Content example
Snow / 80	
A 21	Ice/Snow, speed limit 80 kph 


Variant	A 21		
Austria			
Category	f	%	Score
Certain	33	82,5	82,5
Very probable	6	15	11,3
Probable	1	2,5	1,3
Opp. meaning			
Wrong			
Don't know			
No response			
Total	40	100	95,0
Czech Republic			
Category	f	%	Score
Certain	40	76,92	76,92
Very probable	9	17,31	12,98
Probable	3	5,77	2,88
Opp. meaning	0	0	0
Wrong			
Don't know			
No response			
Total	52		92,8
Overall score	92		93,9

Most frequent responses	A 21
Category 1	Snowfall, 80
	Attention snowfall, 80
	Drive carefully, snowfall, 80
Category 2	Attention on snowy road surface
	Attention, dangerous weather condition, 80
Category 3	Reduce speed, dangerous situation
Category 4	
Category 5	

This referent showed a snowflake, indicating “Snowfall” in combination with the speed limitation and scored at 93,9. Again the answers show that the testing persons repeated the information given from the left to the right side in reading order. In Austria 33 answers for referent A21 were given within category 1, all of them include the speed limitation and the explanation of “Snowflake”. 25 answers mention the term “snow” first.

This was comprehended very well, picture content is approved.

6. Obstacles on the road

Ref. Nr.	VMS Content example
Objects/Obstacles on the road / 80	
C 40	Objects or obstacles on the road ahead, speed limit 80 kph 

Variant	C 40		
Austria			
Category	f	%	Score
Certain	15	45,5	45,5
Very probable	1	3,0	2,3
Probable	8	24,2	12,1
Opp. meaning	0	0	
Wrong	8	24,2	
Don't know	1	3,0	
No response			
Total	33	100	59,8
Czech			
Category	f	%	Score
Certain	16	32	32
Very probable	6	12	9
Probable	22	44	22
Opp. meaning		0	0
Wrong	5		
Don't know			
No response	1		
Total	50		63
Overall score	83	C	61,4



Most frequent responses	C 40
Category 1	80, obstacles on the road
	Drive carefully, speed 80, obstacles on the road
	Handicap on the road, 80
Category 2	Handicap on road, reduce speed
Category 3	Reduce speed 80
	Speed limit 80
	Attention, speed 80
Category 4	
Category 5	Damaged road surface
	Road surface slippery
	Exit ahead, attention
	Road surface destroyed

This referent showed the pictogram of “Obstacles on the Road” in combination with the speed limitation (80) and scored at 61,4.

The referent “Obstacles on the Road” was tested within the 1st CT and was redesigned afterwards, due to low ISO Scores (Variant A: 14,2 % - Variant B: 26,8 % - Variant C: 3,5%). The referent was improved by design to increase its score from 26.8% (CT) to 66% within the 2nd CT.

Within this test series comprehension is lower. Often, only one part of the given information was mentioned (see above: “Attention, speed limitation”, “Reduce Speed”). The wrong answers stress the terms of “Road surface damaged or slippery”.

7. Radar

Ref. Nr.	VMS Content example
	80 / Radar
B 41	Speed limit 80 kph, speed limit area under speed camera surveillance 
	Road works / 60 / Radar / Fines doubled
A 43	Road works, 60 kph speed limit, area under speed camera surveillance, violations imply doubled fines 

Variant	B 41			A 43		
Austria						
Category	f	%	Score	f	%	Score
Certain	38	92,68	92,68	2	5,13	5,13
Very probable	3	7,32	5,49	28	71,79	53,85
Probable		0,00	0,00	8	20,51	10,26
Opp. meaning		0,00	0,00	0	0	0
Wrong				1		
Don't know						
No response						
Total	41		98,2	39		69,2
Czech						
Category	f	%	Score	f	%	Score
Certain	52	86,67	86,67	3	5,77	5,77
Very probable	8	13,33	10,00	48	92,31	69,23
Probable		0,00	0,00		0,00	0,00
Opp. meaning	0	0	0		0,00	0,00
Wrong				1		
Don't know						
No response		0	0			
Total	60		96,7	52		75
Overall score	101	A	97,45	91	A	72,1

Most frequent responses	B 41	B43
Category 1	Radar control, 80	road works, speed limit 60km/h, speed control, double road police or fines
	Reduce speed limit, radar control, 80	road works, speed limit 60km/h, speed control, double road police force
		road works, speed limit 60km/h, radar-speed trap, fine 2x
Category 2	Reduce speed, 80	road works, speed limit 60km/h, speed control
	80	road works, speed limit 60km/h, speed control
	Radar control	road works, speed limit 60km/h, speed control
		road works, speed limit 60km/h, speed control (police), speed trap
Category 3		road works
		road works, speed limit 60km/h, diversion possible
Category 5		Doubled radar

The sign B41 showed an animated version of “Radar” in combination with the speed limitation.



The referent “Radar” was tested within the CAT, where it scored 95,5; within the CST this score could be even improved to 97,45.

The results for the tested animated versions are comparable to the results of the static versions (best static version at the CJT reached the Median of 96,8). Picture content of the pictogram is approved, both versions (animated and static) worked well.

The referent B43 was tested in order to analyse the quantity of information that can be processed. It depicted a combination of the 4 referents “Road works”, “80”, “Radar”, and “Fines doubled”. The score of this referent is high enough (72,1), although the number of “certain” answers is very low (5 times of 91 participants).

Most of the participants went through the pictograms in reading order; most of them (76 participants) mentioned 3 pictograms, which was categorized as “very probable”. But only a few of the participants comprehended the last part of the given information “fines doubled”. This sign is not in use in Europe, and was also tested within the CT, where it reached the ISO score of 24,9.

8. Lane related speed limitations

Ref. Nr.	VMS Content example
A 46	<p>Speed limitations (reduced size): Left lane 130 kph, middle lane 100 kph, right lane to motorway exit 80 kph. Arrows referring to lanes underneath the limitations, at reduced size</p> 
B 47	<p>Speed limitations: Left lane 130 kph, middle lane 100 kph, right lane to motorway exit 80kph. Arrows referring to lanes beside the limitations</p> 




Variant	A 46			B 47		
	A			B		
Austria	A			B		
Category	f	%	Score	f	%	Score
Certain	27	67,5	67,5	31	67,4	67,4
Very probable	2	5,0	3,8	7	15,2	11,4
Probable	11	27,5	13,8	8	17,4	8,7
Opp. meaning						
Wrong						
Don't know						
No response						
Total	40	100	85	46	100	87,5
Czech Republic	A			B		
Category	f	%	Score	f	%	Score
Certain	22	42,31	42,31	27	45,00	45,00
Very probable	6	11,54	8,65	14	23,33	17,50
Probable	23	44,23	22,12	19	31,67	15,83
Opp. meaning						
Wrong						
Don't know						
No response						
Total	52		73,1	60		78,33
Overall score	92		79,05	106		82,9

Most frequent responses	A 46	B 47
Category 1	Speed limits for lanes: 130 – 100 - 80	Speed limits for lanes: 130 – 100 - 80
Category 2	On the right lane exit, 80	Speed limit 100 for the middle lane
	Speed limit 80 on the right line	Speed limit 80 on the right line
	Reduce speed, 80 on the right lane	Change lane, speed 80
Category 3	Marking of speed limits in the traffic lanes	Three traffic lanes with the individual speed limits, the right one is for leaving the highway
	Permitted speeds in the individual traffic lanes	Speeds limits in the connection of for the change of traffic lanes use
	Speed limits for individual traffic lines	Speed limits in the traffic lanes
	Three different speed limits in the individual traffic lines	For turning use the right traffic lane
	Speed limits in the individual traffic lines	Three traffic lanes with the individual speed limits, the right one is for leaving the highway

The sign showed three different speed limitation dedicated to the lanes. Variant A46 used a smaller font than variant B47. Arrows indicating the dedication to the lanes had been shown directly below the speed limitation within variant A46, whereas at variant B47 the arrows were placed on the right side of the speed limitation.

Both variants worked well (Variant A46: 79,05; Variant B47: 82,9), with a slightly preference to variant B47. There are differences between the two testing countries, because not all participants mentioned all the speed limits shown on the sign (category 1 “certain”), but within all categorized answers (category 1-3) the assignment to the lanes was mentioned and comprehended.

9. Variants indicating “No overtaking and Speed limit”

Ref. Nr.	VMS Content example
	Fog / No overtaking / 80
A 16	Fog / No overtaking / speed limit 80 kph 
	Accident happened / No overtaking / 80
B 29	Accident happened / No overtaking / speed limit 80 kph 
	Oncoming illegal traffic / No overtaking / 80
C 36	Oncoming illegal traffic / No overtaking / speed limit 80 kph 

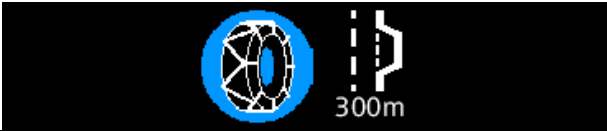


Variant	A 16			B 29			C 36		
Austria									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	21	52,5	52,5	30	65,2	65,2	6	18,2	18,2
Very probable	9	22,5	16,9	8	17,4	13,0	4	12,1	9,1
Probable	7	17,5	8,8	6	13,0	6,5	13	57,6	28,8
Opp. meaning	0	0,0	0,0						
Wrong	3			2	4,3		3	9,1	
Don't know	0						1	3,0	
No response									
Total	40		78,1	46	100	84,8	33	100	56,1
Czech									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	25	48,08	48,08	36	60,00	60,00	2	4	4
Very probable	20	38,46	28,85	18	30,00	22,50	29	58	43,5
Probable	6	11,54	5,77	4	6,67	3,33	16	32	16
Opp. meaning	0	0	0	0	0	0	0	0	0
Wrong	0			2			2		
Don't know									
No response	1						1		
Total	52		84,7	60		85,83	50		63,5
Overall score	92	A	81,4	102	B	85,31	83	C	59,8

Most frequent responses	A 16	B 29	C 36
Category 1	Speed limit 80, no overtaking, fog	Accident happened, no overtaking, speed 80	Speed limit 80, no overtaking oncoming illegal traffic
	Impaired visibility, speed 80, do not overtake	Accident happened, reduce speed, no overtaking	No overtaking, oncoming illegal traffic, reduce speed to 80
	No overtaking because of foggy weather conditions, 80	Accident, no overtaking, speed limit 80	Attention oncoming illegal traffic, reduce speed to 80, no overtaking
Category 2	Speed 80, no overtaking, weather conditions	Speed limit, no overtaking	Attention, no overtaking, reduce speed
	No overtaking, fog, reduce speed	No overtaking, reduce speed	Attention oncoming illegal traffic, reduce speed
	Fog, speed reducing	80 speed limit, no overtaking, accidents are possible	Reduce speed, no overtaking
			Oncoming illegal traffic, no overtaking
Category 3	Speed 80	Reduce speed	Oncoming illegal traffic
	No overtaking	Speed 80	No overtaking
	Reduce speed	Attention accident	Reduce speed to 80
	Poor weather conditions, no overtaking		
Category 4			
Category 5	Oncoming traffic, no overtaking	Accident on the left lane	Car drives 80, reduce speed
	Oncoming traffic, reduce speed	Speed 30 on the right lane	Reduce speed
	Reduce speed to 80, oncoming traffic	No overtaking in the middle lane	

The sign showed three different combinations of “No overtaking” and “Speed limitation” together with fog (A16, no animation), accident happened (B29, static), and oncoming illegal traffic (C36, animated). Variant B29 was comprehended best, scoring 85,31. Variant A16 depicted the static version of “Fog” and reached a score of 81,4. The static version of the referent “Fog” was first tested within the CT, where it scored 80,8. Results are comparable.

Variant C36 showed an animated version of “Oncoming illegal traffic” together with the sign of “No overtaking” and the speed limitation. The meaning of “Oncoming illegal traffic” had been tested several times (static as well as animated), the animated version reached a score of 40,55 within the last test series (CAT) and was recommended to be announced before displaying it on the roads, because it could not be improved by further design. Within the CST the score is 59,8. The ISO score was improved, but still there is a need of introducing this referent’s meaning before using it on the roads.

10. Snow Chains

Ref. Nr.	VMS Content example
Snow chains / lay-by in 300 m	
A 6	Snow chains obligatory, lay-by (reduced size), in 300 meters (small font size) 
Snow chains / lay-by in 300 m	
B 7	Snow chains obligatory, lay-by, in 300 meters (medium font size) 
Snow chains / between Pach and Stena	
C 8	Snow chains obligatory, in the stretch between exits to Pach and Stena (medium font size) 

Variant	A 6			B 7			C 8		
Austria									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	29	72,5	72,5	35	76,1	76,1	14	42,4	42,4
Very probable	10	25,0	18,8	9	19,6	14,7	15	45,5	34,1
Probable	1	2,5	1,3	3	6,5	3,3	3	9,1	4,5
Opp. meaning							0	0,0	0,0
Wrong							1		
Don't know							0		
No response									
Total	40		92,5	46	100	94,0	33		81,1
Czech Republic									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	13	25	25	30	50	50	43	86	86
Very probable	27	51,92	38,94	20	33,33	25	0	0	0
Probable	10	19,23	9,62	6	10	5	1	2	1
Opp. meaning	0	0	0	0	0	0	0	0	0
Wrong									
Don't know									
No response	2								
Total	52		73,6	60		80	50		87
Overall	92	A	83,05	106	B	87	83	C	84,05

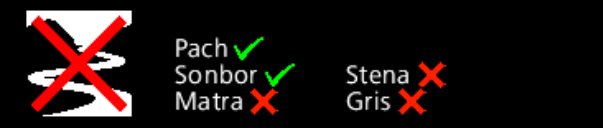

score								
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Most frequent responses	A 6	B 7	C 8
Category 1	Lay-by space for tyre chains application	Place reserved for mounting of tyre chains (300m)	Tyre chains between Pach and Stena
	Use tyre chains, lay-by 300m	Within 300m lay-by lane for tyre chains installation	For driving to Pach or Stena there are chains necessary
	Tyre chains, deviation 300m		
	Place reserved for mounting of tyre chains (300m)		
Category 2	Use tyre chains in the displayed area, next 300 m	Use tyre chains, parking area-resting place	Use tyre chains in the displayed area
	Use tyre chains, parking area, 300 m	Use tyre chains in the displayed area, 300 m	Tyre chains
	Use tyre chains, parking area-resting place, 300 m		
Category 3	Resting area in 300 m	Lay by, 300 m	
	Use tyre chains	Use tyre chains	
	Lay by, 300 m	Resting area in 300 m	
Category 5			No reaction
			Exit Stena

All three variants showed the symbol of “Snow chains” and were comprehended well. For variant C8 the indication of two places called Pach and Stena have not been mentioned as places. The fact that these names had been introduced to the participants beforehand was not taken into consideration for the analysis.

Variant B, using a bigger font, received the highest ISO score of 87.

11. Pass ahead closed

Ref. Nr.	VMS Content example
Pass ahead / Pach and Sonbor reachable	
A 1	<p>Pass/mountain road ahead closed, destinations Pach and Sonbor are reachable, Matra, Stena, and Gris are not (small font size).</p> 
Pass ahead / Pach and Sonbor reachable	
B 2	<p>Pass/mountain road ahead closed, destinations Pach and Sonbor are reachable, Matra, Stena, and Gris are not (medium font size).</p> 

Variant	A 1			B 2		
	f	%	Score	f	%	Score
Austria						
Category	f	%	Score	f	%	Score
Certain	3	7,7	7,5	9	20,0	19,6
Very probable	6	15,4	11,3	16	35,6	26,1
Probable	13	33,3	16,3	12	26,7	13,0
Opp. meaning	0	0	0	1	2,2	-2,2
Wrong	10	25,6		2	4,4	
Don't know	7	17,9		5	11,1	
No response	1					
Total	40	100	35	45	100	56,5
Czech Republic						
Category	f	%	Score	f	%	Score
Certain	1	2,50	2,50	14	25,45	25,45
Very probable	14	35,00	26,25	10	18,18	13,64
Probable	3	7,50	3,75	9	16,36	8,18
Opp. meaning		0,00	0		0,00	0,00
Wrong	16			20		
Don't know	6			2		
No response				0		
Total	40		32,5	55		47,3
Overall score	80	A	33,75	100	B	51,9

Most frequent responses	A 1	B 2
Category 1	Pass ahead closed, Sonbor is reachable	Sonbor open, pass closed
	Sonbor open, pass closed	Pach and Stena are reachable, pass ahead closed
Category 2	Pass is closed, some places are not reachable	Pass is closed, some places are not reachable
	Pass is closed, some places are reachable	Pass is closed, some places are reachable
Category 3	Curvy street, not drive through, some places	Some places are not open
	Some places closed	Sonbor is reachable
	Sonbor is open	Street into the alps is closed
Category 4		Pass to Sonbor is closed, choose different way
Category 5	Exits available, choose exit for Sonbor	Floodings
	River crossing	Different exits to villages
	Serpentines	Didn't catch the names of the villages, will drive on
	Information about places around, drive carefully and slow down	



Both variants showed the same information, variant A1 used a smaller font than B2.

Variant B2 reached a higher score (51,9) than A1 (33,75).

The indication of different places, reachable and not reachable, was comprehended, although the names of the villages were not remembered and mentioned by all of the participants. The context of the given information about the simulated journey helped the participants to comprehend the meaning of the sign, answers like "Sonbor is reachable", "the pass is closed, but different places are open" lead to this assumption. Displaying also names of places around and introducing the participants to travelling through mountains certainly increased the score. Still, both variants got a high number of "wrong answers" (26 for variant A, 22 for variant B), indicating "serpentine" or "curvy street". A high number of participants also mentioned that the given information was too difficult to read or comprehend.

Comparing the results of this test with the results of the test of animated pictograms, where this pictogram scored 16,25 the comprehension of the pictogram could be improved by including the context.

12. Exit closed




Ref. Nr.	VMS Content example
Exit after exit closed / Exit 100 to Ibus reachable	
A 4	Exit 80 to Mels is closed, exit 100 to Ibus is available, Mels crossed out 
Exit after exit closed / Exit 100 to Ibus reachable	
C 5	Exit 80 to Mels is closed, exit 100 to Ibus is available 

Variant	A 4			C 5		
Austria						
Category	f	%	Score	f	%	Score
Certain	17	41,46	41,46	8	20	20
Very probable	16	39,02	29,26	14	35	26,25
Probable	6	14,63	7,317	9	22,5	11,25
Opp. meaning	0	0	0	5	12,5	-12,5
Wrong	2			2		
Don't know	0			2		
No response						
Total	41		78,1	40		45
Czech						
Category	f	%	Score	f	%	Score
Certain	21	40,38	40,38	9	18,00	18,00
Very probable	18	34,62	25,96	7	14,00	10,50
Probable	8	15,38	7,69	22	44,00	22,00
Opp. meaning		0	0		0	0
Wrong	1			12		
Don't know	1					
No response	3					
Total	52		74,0	50		50,5
Overall score	93	A	76,05	90	B	47,75

Most frequent responses	A 4	C 5
Category 1	Second exit is closed, take the Exit to Ibus	Exit to Mels closed, take the next exit to Ibus and look for different way to Mels.
	The exit to Mels is closed, I will go on, Ibus is reachable	
Category 2	Will take the next exit to Ibus, Mels is not reachable	Mels exit is closed, will go on
Category 3	Ibus is the next exit	Mels is closed
		Driving speed 100, exit Ibus
		Exit Mels is closed (exit speed 80)
Category 4		Exit Mels ahead, go for Mels
Category 5		Exit speed 80 and 100
		30 km to Mels

Both signs showed the referents “Next exit closed” including information about exit “Mels” and exit “Ibus”. Variant A4 used an animation, where Mels was crossed out and showed a green tick for Ibus. Variant A4 reached the score of 76,05 and can be recommended. Variant C5 in comparison scored 47,75. A number of answers for variant C5 indicate the “exit speed 80” or even only mention the speed limitations at the exit (“exit speed 80 and 100”, see above), which then had to be categorized as “wrong”.

13. Diversion to Lans (1) – Galno (2) Spitel (3)

Ref. Nr.	VMS Content example
Road ahead closed, diversion to Lans (1) – Galno (2) Spitel (3)	
A 3	Road ahead is closed, take next exit, diversion 1, 2 or 3 to Lans, Galno, or Spitel (medium font size) 
Tunnel ahead closed, diversion to Lans (1) – Galno (2) Spitel (3)	
B 10	Tunnel ahead is closed, road closed/ take next exit, diversion 1, 2 or 3 to Lans, Galno, or Spitel (medium font size) 
Congestion, take next exit, diversion to Lans (1) – Galno (2) Spitel (3)	
C 24	Congestion, road closed/take next exit, diversion 1, 2 or 3 to Lans, Galno, or Spitel (small font size) 

Variant	A3			B10			C24		
Austria									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	20	52,63	52,63	18	39,13	39,13	6	17,14	17,14
Very probable	17	44,74	33,55	6	13,04	9,78	16	45,71	34,29
Probable	1	2,63	1,32	16	34,78	17,39	10	28,57	14,29
Opp. meaning	0	0,00	0,00	3	6,52	-6,52	0	0,00	0,00
Wrong	0			3			1		
Don't know				0			2		
No response	3								
Total	41		87,5	46		59,8	35		65,7
Czech Republic									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	17	32,69	32,69	7	11,67	11,67	11	22,00	22,00
Very probable	28	53,85	40,38	45	75,00	56,25	15	30,00	22,50
Probable	7	13,46	6,73	3	5,00	2,50	22	44,00	22,00
Opp. meaning	0	0	0	3	5,00	-5,00	0	0	0
Wrong	0			2			2		
Don't know									
No response									
Total	52		79,81	60		65,4	50		66,5
Overall score	93	A	83,65	106	B	62,6	95	C	66,1

Most frequent responses	A3	B10	C24
Category 1	Road ahead closed, I take the next exit for Galno (marked 2)	Tunnel ahead is closed, way to Galno open	Road ahead closed, Congestion ahead, Galno is reachable
	Road ahead closed, I take the exit for Galno (marked 2), other diversions	Galno reachable via diversion 2, tunnel ahead closed	Exit to Galno follows, congestion possible, road ahead is not possible to drive
		Next exit is for Galno, tunnel ahead closed	
Category 2	Road ahead closed, I take the second exit for Galno	Tunnel ahead is closed	Congestion possible, take next exit
	Go right for Galno	Next exit is for Galno	3 villages are reachable at the next exit
	Road ahead closed	Exit right is for Galno	Road ahead closed, go to Galno
Category 3	Take the next exit for Galno	Galno is reachable	Take the second exit to Galno, there is congestion
	Next one is for Galno	Way to Galno free	Information about Congestion, take the exit to Galno
	On the right lane to Galno		I drive to Galno
Category 4		Diversion within a tunnel	On the left lane congestion, the middle lane is closed, on the right lane way to Galno
		Cant drive to Galno, is forbidden	
		Exit Galno within the tunnel	
Category 5		Exit on the right side, left side exit forbidden	
		Only drive through the tunnel with special fuel.	
		Information about exits.	




The pictogram A3 “Road ahead closed” was combined with the “Rerouting arrow”, which had been explained to the participants beforehand.

The referent A3 of “Road ahead closed” was also tested within the CT and scored with 83,4. Within this test series the referent scored with 83,65, due to the given task of the journey the participants comprehended the “Rerouting arrow” and mentioned, that they would take the journey to Galno. Scores are comparable.

Referent C24 showed the combination of “congestion ahead”, “Road ahead closed” as well as the “rerouting arrow”. It reached the ISO Score of 66,1. Only 18 out of 85 participants mention the whole meaning of this referent, high numbers of participants only mention the term of congestion or refer to the names of the exits, due to the given route information introduced to the participants beforehand.

Variant B10 combined the animated version of “tunnel ahead closed” and the rerouting arrows indicating diversions to Lans, Galno, and Spitel. It scored 62,6, which is significant lower in comparison to “Road ahead closed”. The number of answers within category 4 (opposite meaning) shows the animation of the closed tunnel was not comprehended. 6 out of 106 participants pointed out, that there is a “diversion within the tunnel”, the next “exits are in the tunnel”. In comparison to the last test of animated pictograms, where all three variants of “tunnel ahead closed” scored below zero, the improvement is given.

14. Congestion between Sigstal and Salgur

Ref. Nr.	VMS Content example
80 / Congestion between Sigstal and Salgur	
A 28	80 kph, Congestion, between Sigstal and Silgur (small font size) 
Congestion between Sigstal and Salgur	
B 27	Congestion, between Sigstal and Silgur (medium font size) 
Congestion between Sigstal and Salgur, last exit before congestion	
C 25	Congestion, between Sigstal and Silgur – Last exit before congestion is 14/Kempen 

Variant	A 28			B 27			C 25		
Austria									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	5	12,8	12,2	11	23,9	23,9	8	24,2	24,2
Very probable	18	46,2	32,9	3	6,5	4,9	0	0	0
Probable	14	35,9	17,1	10	21,7	10,9	4	12,1	6,1
Op. meaning				0	0		0	0	
Wrong	2	5,1		20	43,5		20	60,6	
Don't know				2	4,3		1	3,0	
No response									
Total	39	100	62,2	46	100	39,7	33	100	30,3
Czech Republic									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	11	22	22	17	34	34	7	14	14
Very probable	34	68	51	37	74	55,5	11	22	16,5
Probable	4	8	4	0	0	0	26	52	26
Opp. meaning	0	0	0	0	0	0	0	0	0
Wrong	1			5			5		
Don't know							1		
No response	2			1					
Total	50		77	50		89,5	50		56,5
Overall Score	89	A	69,6	96	B	64,4	83	C	43,4

Most frequent responses	A 28	B 27	C 25
Category 1	80, Congestion possible between Sigstal and Salgur	Congestion possible between Sigstal and Salgur	Congestion possible between Sigstal and Salgur
	80, reduce speed, Congestion warning	Congestion warning	Congestion ahead
	80, reduce speed, Congestion ahead	Congestion ahead	
Category 2	Congestion warning	Information about possibility of dense traffic	Congestion from Sigstal on
		Congestion between two places	Drive carefully, congestion ahead
Category 3	Take exit to Sigstal, congestion ahead	Slow traffic to drive to Sigstal	Slow traffic ahead
	Take next exit to Sigstal due to congestion	Attention slow traffic	
Category 4			
Category 5	Drive 80, no idea why	Exit to two places	Exit
		Exit	Exits ahead
		Exit in 30km	Information about upcoming places




These three variants showed the sign of “congestion” and indicated two different towns “Sigstal and Salgur”, variant A28 showed additionally the speed limitation 80.

Variant A28 worked best, reaching a score of 69,9. It seems that indicating the context by showing a speed limitation could improve the comprehensibility.

There are significant differences for the answers for variant B27 and C25 between the two testing countries. Higher numbers within the “wrong answers” category for the variants B (in sum 20 for the Austrian part) as well as for variant C (in sum 20 for the Austrian part) describe the lower score for Austria. Most of the answers indicate that “Sigstal” and “Salgur” are the next, upcoming exits or places to go.

The Czech answers do not allow this interpretation.

15. Congestion, Exit recommended

Ref. Nr.	VMS Content example
	Congestion, Exit 14 to Kempen recommended
A 22	80 kph, Congestion, between Sigstal and Silgur (small font size) 
	Congestion, Exit 14 to Kempen recommended
B 49	Congestion, between Sigstal and Silgur (medium font size) 
	Congestion, Exit 14 to Kempen recommended
C 26	Congestion, between Sigstal and Silgur – Last exit before congestion is 14/Kempen 

Variant	A 22			B 49			C 26		
Austria									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	14	35,9	35,9	4	8,9	8,7	3	9,4	9,1
Very probable	11	28,2	21,2	4	8,9	6,5	3	9,4	6,8
Probable	11	28,2	14,1	37	82,2	40,2	20	62,5	30,0
Opp. meaning	0	0							
Wrong	3	7,7					6	18,8	
Don't know									
No response									
Total	39	100	71,2	45	100	55,4	32	100	46,2
Czech Republic									
	A			B			C		
Category	f	%	Score	f	%	Score	f	%	Score
Certain	11,00	21,15	21,15	17	28,33	28,33	7	14	14
Very probable	34,00	65,38	49,04	37	61,67	46,25	11	22	16,5
Probable	4,00	7,69	3,85	0	0,00	0,00	26	52	26
Opp. meaning	0,00	0,00	0,00	0	0,00	0,00	0	0	0
Wrong	1,00			5			5		
Don't know							1		
No response	2,00			1					
Total	52		74,04	60		74,58	50		56,5
Overall	91	A	72,62	105	B	64,99	82	C	51,35

score									
-------	--	--	--	--	--	--	--	--	--

Most frequent responses	A 22	B 49	C 26
Category 1	Attention congestion ahead, take exit at Kempen	Congestion, exit to Kempen	Would take exit to Kempen, congestion after this exit
	Congestion possible, take Exit right to Kempen	Kempen, next exit, congestion	Exit 14 to Kempen recommended, congestion possible
	Exit to Kempen recommended, congestion		
Category 2	Exit, because of congestion	Exit 14 on the right side, slow traffic	Slow traffic ahead, take exit 14
	Possible congestion, take Exit		Exit, congestion around
Category 3	Exit, I don't want to go to Kempen	Exit Kempen	Exit, congestion there
	Congestion, I don't want to drive to Kempen	Exit Kempen, at Kempen congestion	
		Exit 14	Exit to Kempen
		Exit	
		Congestion because of Exit	
Category 4			
Category 5		Attention exit	Exit at 14km
		Attention three lanes	Exit within 14 km
			Exit with three cars
			Exit, lay by




The three variants showed combinations of “congestion ahead” and “Next exit (14) to Kempen”. The difference between the variants belonged to the order of the information given, as well as to the font size.

Variant A22 reached the highest score of 72,62, whereas B49 scored 64,99 and C26 had the lowest score (51,35).

Again variant C had the lowest size and depicted the congestion pictogram on the top of the “Next exit” pictogram, which led to the assumption that there is an “Exit within 14 km”, “Exit closed, three cars” or “Exit within 14 km”(see answers for variant C above). Participants did not comprehend the “Congestion” pictogram as additional information; the indication of “Next exit” seemed to be more evident and was therefore often mentioned alone (11 times for variant C).

The picture content of variant A22 is approved.

16. Vehicle Broken Down

Ref. Nr.	VMS Content example
Vehicle Broken Down, Congestion, 80	
A 34	Vehicle Broken Down, Congestion ahead, 80kph speed limit 
Vehicle Broken Down, 80, lane merging ahead	
B 35	Vehicle Broken Down, 80kph speed limit, lane merging ahead 
Vehicle Broken Down, 80	
C 33	Vehicle Broken Down, 80kph speed limit 

Variant	A 34			B 35			C 33		
Austria									
Category	f	%	Score	f	%	Score	f	%	Score
Certain	20	52,6	52,6	14	30,4	30,4	26	81,25	81,25
Very probable	13	34,2	24,4	15	32,6	24,5	4	12,5	9,375
Probable	1	2,6	1,3	7	15,2	7,6	2	6,25	3,125
Opp. meaning	0	0		0	0		0	0	
Wrong	4	10,5		10	21,7		0	0	
Don't know									
No response									
Total	38	100	75,6	46	100	62,5	32	100	93,7
Czech Republic	A			B			C		
Category	f	%	Score	f	%	Score	f	%	Score
Certain	23	44,23	44,23	21	35,00	35,00	22	44,00	44,00
Very probable	20	38,46	28,85	20	33,33	25,00	25	50,00	37,50
Probable	9	17,31	8,65	16	26,67	13,33	2	4,00	2,00
Opp. meaning	0	0,00	0,00	0	0,00	0,00	0	0,00	0,00
Wrong	0			2			0		
Don't know									
No response				1			1		
Total	52		81,7	60		73,33	50		83,5
Overall score	90	A	78,65	106	B	67,91	82	C	88,6

Most frequent responses	A 34	B 35	C 33
Category 1	Attention broken car, congestion, drive slowly 80	Attention car broken down, speed 80, one lane open	Broken Car, 80
	Congestion, Drive 80, accident ahead	One lane open, change lane, 80, accident happened	Car broken, reduce speed
	Drive 80, congestion, broken car	Change lane, broken car, reduce speed to 80 km/h	
Category 2	Reduce speed to 80, congestion	Broken Car on the left lane, change lane, 80	Attention broken car
	Congestion, Accident ahead	Broken Car	Attention accident
	Broken car, congestion		Reduce speed to 80
	Accident ahead, 80		
	Broken car, 80		
Category 3	Probable accident, reduce speed		Speed 80
Category 4			
Category 5	On the left lane car broken down	Diversion	
	Possibility for broken cars at this lane	danger of accident (demanding terrain, car function failure)	
		Lay by on the right side	



Variant A34 showed a combination of the animated version of “Car broken down” in combination with “Congestion ahead” and a speed regulation.

Variant B35 showed this sign in combination with the speed regulation as well as the sign for “Only one lane open”. Variant C33 depicted a combination of “Vehicle broken down” with “Speed limitation”.

Variant C33 reached the highest score of 88,6. The picture content is approved as well as for variant A34 (score 81,73).

Variant B35 was not comprehended well (Score 73,33), because of the indication of “Only one lane open”. Participants mention “Diversion on the ride lane”, “Lay by on the right lane” to describe, what they have recognised (12 wrong answers out of 106).

17. Switch off engine

Ref. Nr.	VMS Content example
	Switch off engine, call automobile club
A 9	Switch off engine, OAMTC, ARBO and ADAC automobile club numbers provided (medium font size) 
	Switch off engine, call automobile club
B 48	Switch off engine, OAMTC, ARBO and ADAC automobile club numbers provided (small font size) 

Variant	A 9			B 48		
Austria						
Category	f	%	Score	f	%	Score
Certain	27	67,5	67,5	32	69,6	69,6
Very probable	2	5,0	3,8	1	2,2	1,6
Probable	5	12,5	6,3	3	6,5	3,3
Opp. meaning			0			
Wrong	6	15,0		8	17,4	
Don't know				2	4,3	
No response						
Total	40	100	77,5	46	100	74,5
Czech Republic						
Category	f	%	Score	f	%	Score
Certain	17	32,69	32,69	30	50,00	50,00
Very probable	24	46,15	34,62	9	15,00	11,25
Probable	10	19,23	9,62	11	18,33	9,17
Opp. meaning		0,00	0,00		0,00	0,00
Wrong	1			10		
Don't know						
No response						
Total	52		76,92	60		70,42
Overall score	92	A	77,21	106	B	72,46

Most frequent responses	A 9	B 48
Category 1	switch off the engine, call for help	turn off the engine, call the help
	turn off the engine, call for help Tel.No. 222222	switch off the engine, call ADAC
	turn off engine, call for help 222222	turn off the engine, call ADAC 222222
	turn off engine, call ADAC for help 222222	
Category 2	call emergency numbers	turn off the engine
	information what to do, emergency call number	call ADAC 222222
	Switch off the engine, call for help	
	phone numbers for calling help ADAC 222222	
Category 3	calling for assistance service	turn off the engine, lock the vehicle
	by the case of trouble or defect call phone number 222222	
	call the phone numbers for information	
	in the case of breakdown turn off the engine, phone numbers for the help	
	telephone numbers for technical assistance	
Category 4		
Category 5	Broken car	lock the vehicle
		Car broken

This referent showed an animated version of “Switch off engine” together with the numbers and names of three different automobile clubs. The two tested versions differed from their font size.

Participants had been instructed beforehand, that they are members of the ADAC automobile Club.

Both tested variants were comprehended well, reached a score above 70 (variant A9: 77,21: variant B48: 72,46). “Switch off engine” was also tested within the CAT and scored 50,75 there. An improvement was reached due to the information given beforehand as well as the context. Participants were shown the sign of “Congestion ahead” before this referent.

18. Park and Ride


Ref. Nr.	VMS Content example
	Park and Ride/ 86 Places free, Train departures every 15 minutes
A 45	Park and Ride/ 86 Places free, Train departures every 15 minutes (small font size) 

Variant	A 45		
Austria			
Category	f	%	Score
Certain	16	40,0	40,0
Very probable	17	42,5	31,9
Probable	7	17,5	8,8
Opp. meaning			
Wrong			
Don't know			
No response			
Total	40	100	80,6
Czech			
Category	f	%	Score
Certain	17	32,69	32,69
Very probable	25	48,08	36,06
Probable	10	19,23	9,62
Opp. meaning			
Wrong			
Don't know			
No response			
Total	52		78,4
Overall score		A	79,5

Most frequent responses	A 45
Category 1	parking area, train in 15 min. departure spans
	parking area, time interval of train departures is 15 min
	Park and Ride area, time interval of train departures
	parking area, local transport, departure time intervals
	parking space, + public transport time intervals 15 min
Category 2	Parking area, train
	parking area with train service
	parking area, public transport (train)
	parking area and public transport
	Train runs every 15 minutes
Category 3	Next train in 15 minutes
	City Center reachable by public transport within 15 minutes
	Change here to public transport

This referent showed a combination of “Park and Ride” and “Next train within 15 minutes”. It was comprehended well, reaching a score of 79,5. It is remarkable that no one of the participants mentioned the number of free places indicated within a green field below the “Park and Ride” pictogram.

19. Accident happened

Ref. Nr.	VMS Content example
Accident has happened / 80	
C 30	<p>Accident has happened, 80 kph speed limitation</p> 


Variant	C 30		
Austria			
Category	f	%	Score
Certain	16	48,5	48,5
Very probable	13	39,4	29,5
Probable	1	3,0	1,5
Opp. meaning	0	0	0
Wrong	3	9,1	
Don't know			
No response			
Total	33	100	79,5
referent			
Czech	C		
Category	f	%	Score
Certain	21	42	42
Very probable	7	14	10,5
Probable	18	36	18
Opp. meaning	0	0	0
Wrong	4		
Don't know			
No response			
Total	50		70,5
Overall score	83	C	75

Most frequent responses	C 30
Category 1	Attention, accident happened, reduce speed to 80
	Accident happened, 80
	Reduce speed to 80, accident ahead
Category 2	Car broken down, 80
	Reduce speed to 80, attention
	Danger of accidents, reduce speed, 80
Category 3	Reduce speed to 80
Category 5	Danger zone
	At 80km/h danger of overturning
	Attention, at 80km/h speed danger of overtaking
	Danger of car overturning, speed limit 80km/h
	Danger of skidding, reduce speed
	Impaired driving conditions, reduce speed
	Danger of downfall, reduce speed

This referent can be recommended for the final proposal, reaching a score of 75. Only seven participants (out of 83) answered wrong, indicating “Impaired driving conditions”, “Danger of skidding”, or “Danger of downfall”.

In comparison to the results of the CT, where “Accident happened” scored with 52,7 comprehension was improved.

20. UEFA Champions League

Ref. Nr.	VMS Content example
UEFA Champions League, Exit 24	
C 42	UEFA Champions League football match, take exit 24 

Variant	C 42		
Austria			
Category	f	%	Score
Certain	31	93,9	93,9
Very probable	0	0	0
Probable	0	0	0
Opp. meaning	0		0
Wrong	5	6,1	
Don't know			
No response			
Total	33	100	93,9
Czech Republic	C		
Category	f	%	Score
Certain	41	80,39	80,39
Very probable	2	3,92	2,94
Probable	6	11,76	5,88
Opp. meaning		0	0
Wrong			
Don't know	2		
No response			
Total	51		89,22
Overall score	84	C	91,56

Most frequent responses	C 42
Category 1	Exit 24 to the stadium
	Exit to the Champions League
	Exit 24 to the final destination
Category 2	Champions League Exit
	Take Exit 24
Category 3	Exit for Champions League within 24 km
	Slippery road to the stadium
	Diversion to the football stadium

























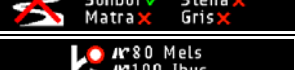
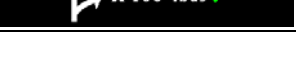
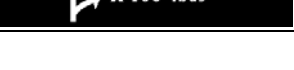
This referent was shown as the final destination of travel C: the “Champions League Soccer Game”. Although this information was never shown before, the high number of certain answers shows, that the context, as well as the symbol was comprehended well.

Among the wrong answers the confusion between “Exit 24” and “Exit within 24 km” has to be mentioned.

This referent is approved.

4. Discussion and Conclusion

Table 3: Conclusions, Final Scores of the Tested Pictograms

Assignment Nr.	Ref Nr.		Score	Ref Nr.		Score	Ref Nr.		Score	Ref. Nr.		Score
1	A37		95,5	B38		93,6	C39		85,45			
2	A11		86,1									
3	B17		84,3	B18		74,9	C19		80,1	C20		66,9
4	C13		62	B15		62,9	C14		33,35			
5	A21		93,9									
6	C40		61,4									
7	B41		96,7	A43		72,1						
8	A46		79,1	B47		82,9						
9	A16		81,4	B29		85,3	C36		59,8			
10	A6		83,1	B7		87	C8		84,1			
11	A1		33,8	B2		51,9						
12	A4		76,1	C5		47,7						

13	A3		83,6	B10		62,6	C24		66,1			
14	A28		69,6	B27		64,4	C25		43,4			
15	A22		72,6	B49		64,9	C26		51,35			
16	A34		78,7	B35		67,9	C33		88,6			
17	A9		77,2	B48		72,4						
18	A45		79,5									
19	C30		75									
20	C42		91,5									

4.1. Specification of a stretch of road by place names (corresponding exits of the motorway)

Variant B 27, score 64

Involved elements (left to right): Danger warning sign "Congestion", place name A , arrow pointing to the right, (towards) place name B

Variant C 8, score 75,5

Involved elements (left to right): "Snow chains compulsory" sign, place name A , arrow pointing to the right, (towards) place name B

Variant C 25, score 43,4

Involved elements (left to right): Danger warning sign "Congestion", place name A , in a second line below A an arrow pointing to the right, (towards) place name B

Data clearly show that a stretch of road, specified by two place names (which is communicated by the elements: place name A [to] place name B) connected by an arrow and pointing towards place B (the end of the stretch), scores significantly higher, if both names and the arrow are positioned along one horizontal line to be read from left to right.

If this concept – one piece of information at one stop along the horizontal reading line – is made more complicated (as seen in the low comprehensibility of variant C 25), the eye is forced to jump to another horizontal line below to perceive the end of the stretch (arrow and place name B), the intended meaning is badly comprehended.

Conclusion

To summarize, there is a clear advantage to show this kind of information gathered on a single horizontal line.

Further research efforts could be worth undertaken by examining another proposal: Place name A (beginning of the concerning stretch of road) shown at the bottom of the VMS display, centred above one arrow, pointing up towards B (end of stretch), positioned again centred above.

4.2. Destinations are reachable/not reachable

Variant B2, score 49,9

The additional pictogram shown at the beginning of this variant (Pass/Mountain road closed) is not referred to here.

Reachable places are signalled by green ticks positioned to the right of a place name, not accessible destinations are marked with a red "x" positioned to the right of a name.

Variant A4, score 76,05

The reachable place is signalled by a green tick positioned to the right of the place name, while the closed destination has no additional markings, except the traffic ban circle of the pictogram "Exit after exit closed".

Variant C5, score 47,75

The reachable place has no additional markings to its name, while the closed destination is crossed out by a superimposed red flashing horizontal bar adding another negating element to the traffic ban circle of the pictogram "Exit after exit closed".

Conclusion

Regarding the results, it is obvious that it is necessary to always display confirmation (here, represented by a green tick) added to the place name of the destination which is reachable. Redundant negations do not yield positive effects. Since a single horizontal negation stroke over a place name is not feasible due to technical reasons, the red "X" for signalling closure is proposed.

5. Further Research Questions

This study was conducted as a simulation. It showed that the given context by indicating travels with a start and endpoint improved the comprehension of most of the pictograms.

Thus, there is a need of further investigation in order to analyse driving behaviour under real conditions. The comprehension of different quantities of given information should be assessed in real driving situations:

- Eyetracking measurements
- Information management and given information, that refers to real-life situations and given real hazards
- Test on response time.

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ANNEX: Handout for test persons

A Series: travelling form the country to the city

You plan to go on a journey to a distant capital city called **Mels**. Along the way, two stops are planned at **Sonbor**, and **Galno**.

Start

Sonbor

Galno

Mels

You are member of the ADAC Club.

Rerouting Arrow



Explanation:

In case a road is blocked, arrows like this with numbers inside indicate alternative routes to be followed. Every number stands for a destination, stated where rerouting begins. Later on, only the arrow with number inside is displayed. Destinations are only reachable by following an alternative route indicated by these arrows.

B Series: going from the city on a skiing holiday

You plan to go on a journey into the mountains for a skiing holiday at **Sonbor**. Along the way, a stop at **Galno** is planned.

Start

Galno

Sonbor

You are member of the ADAC Club.

Rerouting Arrow**Explanation:**

In case a road is blocked, arrows like this with numbers inside indicate alternative routes to be followed. Every number stands for a destination, stated where rerouting begins. Later on, only the arrow with number inside is displayed. Destinations are only reachable by following an alternative route indicated by these arrows.

C Series: travelling to a football match

You plan to go on a journey to a **Champions League football match**. Along the way, stops at **Galno** and **Mels** are planned.

Start

Galno

Mels

Champions League football match

You are member of the ADAC Club.

Rerouting Arrow**Explanation:**

In case a road is blocked, arrows like this with numbers inside indicate alternative routes to be followed. Every number stands for a destination, stated where rerouting begins. Later on, only the arrow with number inside is displayed. Destinations are only reachable by following an alternative route indicated by these arrows.