



## Reducing road traffic noise – how to design effective individual-based interventions

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**Road traffic noise has considerable negative health, social and economic impacts. Apart from technical improvements, targeting the behavior of individual drivers is a further strategy to reduce noise. However, a sound theoretical foundation upon which to design individual-based interventions is needed. This contribution will show how the results of a project that was designed to identify benefits and barriers of low-noise traffic behaviors (specifically Eco-driving and buying low-noise tires) are used as a basis to develop innovative and tailored interventions by means of workshops. These workshops are the final step of the project part that had (1) elaborated a theory-based stage model describing behavior change from the first awakening of problem awareness to the implementation and consolidation of a new, low-noise behavior, (2) substantiated this theoretical framework by means of qualitative interviews, and (3) tested the model with an online survey to identify the intervention potential of the different behavioral predictors. Element of innovative interventions that are based on the results of these previous steps and targeted to specific behaviors and behavioral predictors will be outlined.**

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## **1 INTRODUCTION**

More than 1.2 million people in Switzerland suffer from road traffic noise exceeding the threshold limits<sup>1</sup>. This equals to more than 15% of the Swiss population. Therefore road traffic noise is the most important noise source in the field of environmental noise. In addition to road traffic, noise from railways and airplanes as well as noise from the neighbors, an open-air concert or noisy night owls in the inner cities is disturbing. Creating noise up to a certain extent and suffering its effects, is the individual. Therefore noise abatement starts – aside from technical improvements and legislation – in the head of each individual.

Today the government is already trying to increase awareness of the noise problem by bringing it before the public. The main focus nowadays is to inform about the extent of noise pollution and health risks from excessive noise stress (knowledge supply). The potential for noise reduction using individual motivation for noise-reducing behavior is most likely not realized – not least because of missing fundamentals. A research program at the University of Berne, funded by the Swiss Federal Office for the Environment, aims to fill this gap. It has the double objective of (1) constructing a robust scientific model of the psychological, social and situational factors relevant for changing specific noise-producing behaviors and (2) designing – based on this model – promising interventions for promoting desirable low-noise behaviors. This paper gives an overview of the steps carried out for the elaboration and testing of the (general) stage-model and outlines first ideas of elements for practical interventions to encourage a low-noise driving style (Eco-driving) and to buy low-noise tires.

## **2 METHOD**

A four-step procedure was chosen in order to elaborate different intervention recommendations.

### **2.1 Step 1: Elaboration of a theory-based stage model**

To elaborate a (general) model of the different stages in behavior change a literature research has been conducted in the fields of environmental, social, and health psychology, as well as psychological literature regarding noise annoyance. Within this task the main focus was on two groups of theories: The first group encompassed psychological stage models, such as the transtheoretical model<sup>2</sup>, and the model of action phases<sup>3</sup>. From this theoretical thread the assumption was adopted that behavior change occurs within a process of qualitatively different stages. The second group of theories encompassed continuum models, such as the theory of planned behavior<sup>4</sup>, the norm activation model<sup>5</sup>, the norm activation model added with personal values<sup>6</sup>, the social psychological model of noise annoyance<sup>7</sup>, theories on implementation intentions<sup>8</sup>, and goal-setting theory<sup>9</sup>. With help of these theories, factors were identified which may facilitate or inhibit the individual proceeding within the stages of the behavior change process.

### **2.2 Step 2: Substantiating the model by qualitative interviews**

The theory-based stage model then has been concretized and specified to the topic of traffic noise behavior. This was done with help of qualitative interviews. Eight individual interviews were conducted with experts in noise prevention working in the Swiss national and cantonal

administration, or in NGOs or associations. Eight further interviews were done with other relevant informants, such as traffic planners, vendors, motorcyclists, car drivers, and people who explicitly abstain from motorized individual transport. Interviews were done with help of individual interview guides. They lasted about one hour and were mainly done at the working place of the interviewees. With consent of the interviewees the interviews were tape-recorded. In addition interviewees' statements were protocolled in written form during the interview. The theoretical constructs extracted in the first part of the project provided the codes for the content analysis of the interview data. The analysis was facilitated by a graphical analysis raster representing the different stages of our model.

### **2.3 Step 3: Quantitative test of the model (Online-Survey)**

The model was tested by means of an online-survey with two measurements four months apart. The survey questions were designed to operationalize the model variables as well as the personal attributes that are potential predictors of successful progress through the stages of behavior change. Several different channels were used to gain participants for the survey: 2 articles in print media, notes of the survey on several webpages related to the topic of traffic, invitations to participate via different mailing lists and newsletters. To further encourage the participants there was also a small contest attached to the survey. 1684 persons produced valid responses at the first measurement point (October 2011 through January 2012). Main focus in this paper is on the results of the subgroups of car-drivers and tire-buyers. Within the group of car-drivers ( $N = 890$ , aged 19-80 years, 53% male, 47% female) fell persons who stated to drive a car at least once a month. Within the group of tire-buyers ( $N = 112$ , aged 20-73 years, 53% male, 47% female) fell persons, who stated to intend to buy new tires within the next four month.

### **2.4 Step 4: Creative workshop on Eco-Driving**

Based on the relevant barriers/benefits for Eco-driving identified in step 3 there was a workshop conducted with the aim to use the knowledge of experts in this field to generate and rate a wide range of ideas for key-messages, communication channels and multipliers of the barriers/benefits (Creative workshop). Participating in the workshop were two Eco-Drive instructors, one person of the Swiss umbrella association for Eco-Drive<sup>10</sup>, one traffic psychologist, two environmental psychologists with expertise in intervention design and one expert in communications. The generation of ideas was supported using the brainstorming method, their evaluation by each expert choosing his or her three favorite ideas in regard with attractiveness, expected feasibility, and expected effectiveness. Our suggestions for elements of interventions were created using the different ideas from the experts and our knowledge from the scientific literature on intervention design.

## **3 MAIN RESULTS OF THE DIFFERENT WORKING STEPS**

### **3.1 Results from the elaboration and substantiation of the model (steps 1 and 2)**

Based on the theories mentioned above, we assume that an individual who adopts a low-noise behavior style passes through a process of five qualitatively different stages. The last stage is achieved when the low-noise behavior has repeatedly been performed, and the undesired high-noise activity has not been chosen anymore. Within each stage different cognitive, emotional, and social tasks have to be conquered. Tasks are described by variables in each stage. Failures

may provoke a relapse to one of the preceding stages. To foster the progression of an individual, interventions should ideally match the tasks of the stage the individual is in. The stages we propose in our model are the stages of goal selection, behavior selection, planning, behavior initiation, and evaluation. Transition between stages is described by the following transition variables: intention to avoid traffic noise (transition from stage 1 to stage 2), low noise behavior(s) intention(s) (stage 2 to stage 3), intention to implement low noise behavior(s) (stage 3 to stage 4) and finally the initiation of low noise behavior(s) (stage 4 to stage 5). The individual successfully passed through stage 5 when low noise behavior was carried out several times (cp. figure 1).

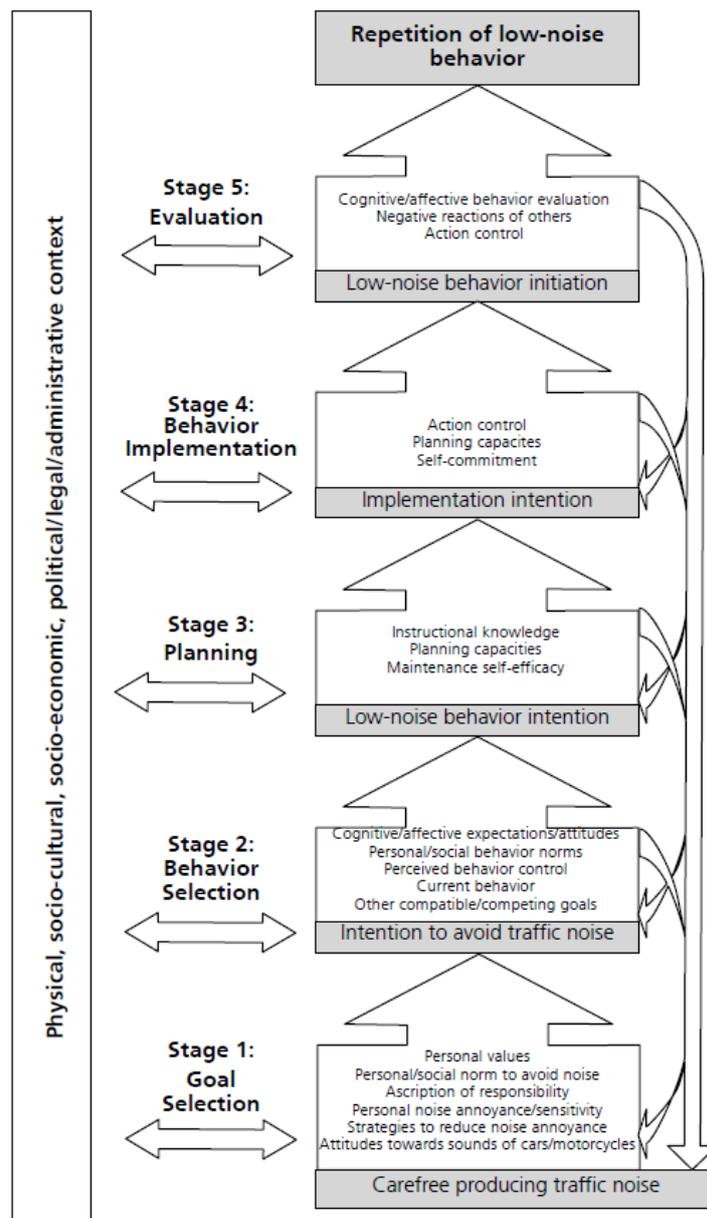


Figure 1: Stage model of changing noise-producing behavior with transition variables and predictor variables

With help of the qualitative interviews different behaviors were identified that individuals could undertake in order to lower the own traffic-noise emissions. We classified them within the two categories of investments and routines (cp. table 1).

Table I: Overview of different low-noise behaviors identified in the qualitative interviews

<b>Low-noise behaviors</b>	<b>Description</b>
<i><b>Investments</b></i>	
Vehicle purchase	<i>Choice to buy a new low-noise vehicle</i>
Purchase of tires	<i>Choice to buy new low-noise tires</i>
Tuning of the vehicle	<i>Abdication to sound-tuning activities</i>
Upkeep of the vehicle	<i>Periodic maintenance of the vehicle, e.g., exchange of worn-down dampers</i>
<i><b>Routines</b></i>	
Travel mode choice	<i>Choice to use slow-traffic (by foot/bicycle) instead of motorized individual traffic (MIV)</i>
Driving style	<i>Low-noise driving style (corresponding to the principles of Eco-Drive)</i>
Carsharing	<i>Use of car-sharing supply instead of owning a car (based on the assumption that there are less car rides when not owning a car)</i>
Sound volume of the stereo	<i>Abdication to listen to music in the car at high volumes</i>

Furthermore, the qualitative interviews allowed for identifying factors that support or inhibit the fulfilling of the tasks of the different stages, as shown in Figure 1. Thus, the intention to avoid traffic noise may be one, but by far not the only factor affecting the intention, planning, initiation and evaluation of one or several of the low-noise behaviors in table I. Moreover, the factors, which are relevant for stage proceeding may differ among the different behavior types. For example, the degree of habituation of the old behavior may be a much stronger barrier for familiarizing new routines, such as a low-noise driving style, than for implementing a low-noise investment, such as purchasing low-noise tires.

### **3.2 Results from the online-survey (step 3)**

From the low-noise behaviors identified in the qualitative interviews we chose one routine, i.e., the low-noise driving style, and one investment, i.e., buying low-noise tires, to evaluate quantitatively within the online survey data (cp. 2.3). With the quantitative data we aimed first at testing the structure of the proposed model of the previous working step. These results are presented elsewhere (cp. the contribution of Kaufmann-Hayoz, et.al. in this session of Internoise 2012). From the model test can be concluded that awareness about the noise problem, which is a predictor of the intention to avoid noise, is a rather distal predictor of behavior implementation. Thus, for example awareness-raising campaigns may exert, if at all, only a weak effect on concrete individual noise reducing actions. Such campaigns should be added with further aspects fostering factors of later model stages.

Following the idea of the stage model, interventions should match the stage where the majority of individuals are in. Stage affiliation was identified with help of a stage algorithm, which consisted of different questions (cp. table 2).

Table II. Stage affiliation of car-drivers and tire-buyers

Stage	Car-drivers		Tire-buyers	
	N	%	N	%
Repetition of Behavior	732	83%	24	21%
<i>,I have been performing Eco-Drive at least once in the past and I intend to do it again'</i>				
<i>,I have bought low-noise tires at least once in the past and I intend to do it again'</i>				
Evaluation stage	54	6%	8	7%
<i>,I have performed Eco-Drive at least once in the past, but I'm not sure, whether I will do it again'</i>				
<i>,I have bought low-noise tires at least once in the past, but I'm not sure, whether I will do it again'</i>				
Implementation stage	10	1%	8	7%
<i>,I have never tried to perform Eco-Drive, but I already know exactly, when and where I will try it for the first time'</i>				
<i>,I have never bought low-noise tires, but I already know exactly when and where I will buy low-noise tires for the first time'</i>				
Planning stage	70	8%	42	38%
<i>,I have never tried to perform Eco-Drive, but I intend to try it'</i>				
<i>,I have never bought low-noise tires, but I intend to do it'</i>				
Goal/behavior selection stage	21	2%	30	27%
<i>,I have never tried to perform Eco-Drive, neither I intend to do it'</i>				
<i>,I have never bought low-noise tires, neither I intend to do it'</i>				
<b>Total</b>	<b>887<sup>1</sup></b>	<b>100%</b>	<b>112</b>	<b>100%</b>

Notes: <sup>1</sup>3 missings

#### *Eco-Driving:*

As shown in table II, more than 80% of the car-drivers stated that they have already been trying Eco-Drive and that they intend to perform Eco-Drive again. Thus, Eco-Drive seems to be known and to be positively appraised and evaluated; participants are (following their self-declaration) on the top of our stage model. Thus, supporting interventions should focus on the maintenance of the low-noise behavior style. Within this last subgroup ( $N=732$ ) we therefore investigated with regression analysis which factors predict correct and frequent application of Eco-Drive. Significant predictors of the correct application score ( $R^2 = .22$ ) can be arranged within four thematic groups:

- *Motivational factors:* awareness of responsibility of the noise problem ( $\beta = .09$ ), feeling of a personal norm to perform Eco-Drive ( $\beta = .13$ ), expectation of positive outcomes ( $\beta = .10$ ), attitude toward the sound of motorcycles ( $\beta = -.10$ )
- *Correct knowledge:* sufficient information about Eco-Drive ( $\beta = .08$ ), (wrong )belief that Eco-Drive harms the vehicle ( $\beta = -.10$ )
- *Routine:* self-estimated frequency of previous eco-drive use ( $\beta = .16$ )

- *Personal attributes:* gender (males state to drive more correctly than females,  $\beta = .15$ ), size of living location (persons living in villages drive more correctly than people living in cities  $\beta = -.08$ ), and vehicle class (drivers of small cars drive more correctly than drivers of luxury cars,  $\beta = -.09$ ).

#### *Purchase of low noise tires:*

Most of the people asked regarding their intention to purchase tires were found in the planning stage (38%, cp. table II). Thus, they have the intention and sufficient motivation to purchase low noise tires but have never done it before so far. Spoken within the means of our model it should be promoted that the individual moves upward from the planning stage to the implementation stage by building up a high intention to implement the low noise behavior (buying low noise tires). With regression analysis factors were identified which support this moving up. As significant predictors of the implementation intention ( $R^2 = .56$ ) were found in addition to the intention to act ( $\beta = .51$ ) only the knowledge about low noise tires and where to buy them ( $\beta = .44$ ).

### **3.3 Results from the expert workshop on Eco-drive (step 4)**

The following ideas show a choice of descriptive elements for interventions to encourage low noise driving behavior. The ideas describe not necessarily the most important, best rated or most often mentioned ones from the expert workshop but best combine the findings from the survey with the opinions of the experts.

Ideas for strengthening the motivation to practice Eco-Drive:

- Raising awareness for the noise problem in the concrete situation (Showing the people concerned by this particular noise, dB-Meter)
- Enable own experiences with Eco-Drive to show saving possibilities (fuel) as well as to become conscious about how to improve the actual driving style

Ideas for improving the proper knowledge about Eco-Drive:

- Especially with older persons there should be clarified that driving in high gears and with full throttle (common elements of Eco-Driving) does not harm the car neither the environment

Ideas for building routine:

- Experienced people could judge the proper application of Eco-Driving screening the sound of the vehicle. Until hearing is trained to properly judge Eco-Driving, it is important to regularly check engine speed (rpm) with the corresponding cruise speed. Memory aids, e.g., a sticker in the car, could draw attention to the engine speed display.

## **4 DISCUSSION AND IMPLICATION FOR THE PRACTICE**

Combining sequentially literature research, qualitative interviews provided a good approach to successfully develop a stage model of noise producing behavior and specify it for the domain of road traffic noise (figure 1). The online-survey in a next step provided a first empirical confirmation of the model structure as a whole. Also differences between routine behavior (Eco-driving style) and investment behavior (purchase of low noise tires) seem to be relevant and have to be taken into account when designing tailored interventions. Depending on the desired impact

(increase of awareness for noise problems or encouragement of a particular low noise behavior) the interventions have to be designed differently. Information about the general extent of noise pollution and health risks from excessive noise stress, which is the main focus of governmental information to the entire public these days, increase (little) awareness for the noise problem but hardly encourage any low noise behavior of the individual. The potential for noise reduction using individual motivation for noise-reducing behavior can significantly be increased when the interventions are tailored to the target group because there were found major differences, e.g. with age, gender etc.

## 5 OUTLOOK

Taking into account the results we will advance the intervention ideas in order to develop a concrete set of intervention instruments. These instruments are aimed at reducing road traffic noise by means of individual behavior change on the one hand, and by increasing awareness of the noise problem on the other hand, in order to enhance acceptance from the public for noise reduction measurements, such as speed reduction in living areas. We are also planning on testing and evaluating the instruments in an intervention campaign on Eco-driving in a city in Germany.

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