# Reducing air-pollution: A new argument for getting drivers to abide by the speed limit?

P. Delhomme, J. Chappé, K. Grenier, M. Pinto, Cécile Martha

*Accepted version in Accident Analysis and Prevention*

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**Delhomme*, P., Chappé*, J., Grenier*, K., Pinto*, M., & Martha*, C.**

*Laboratoire de Psychologie de la Conduite (LPC),
Institut National de Recherche sur les Transports et leur Sécurité (INRETS).
2, Avenue du Général Malleret-Joinville
F - 94114 ARCUEIL CEDEX

Contact: patricia.delhomme@inrets.fr

Abstract:

Speeding is one of the main factors of car crash-risk, but it also contributes to increasing air-pollution. In two studies we attempted to lead drivers to abide by speed limits using "reducing air-pollution" as a new argument. We presented prevention messages that highlighted the role of speeding in increasing "crash-risk", "air-pollution", or both (Studies 1 and 2). The messages were also positively or negatively framed (Study 2). Given that women are more concerned with environmental issues than are men, we expected the following hypotheses to be validated for women. The message with the "air-pollution" argument was expected to be evaluated more positively than the "crash-risk" message (H1). The "air-pollution" and "crash-risk and air-pollution" messages were expected to be more effective than the "crash-risk" message on the behavioral intention to observe speed limits (H2a) and on the perceived efficacy of speed-limit observance in reducing air-pollution (H2b; Studies 1 and 2). Furthermore, positive framing was expected to be more effective than negative framing (H3), and presenting a message to be more effective than presenting no message (H4; Study 2). Broadly, our results argue in favor of our hypotheses. However in Study 2, the effects of message framing did not allow us to conclude that negative or positive framing was superior. All in all, messages with the "air-pollution" argument were more effective at leading drivers to observe speed limits. Thus, environmental protection may be a fruitful route to explore for increasing road safety.

## 1. Introduction

Excessive speeding is one of the main factors of crash risk (Aarts & Schagen, 2006; Delhomme & Cauzard, 2000; Elliot, Armitage, & Baughan, 2003). Drivers are widely informed about the positive relation associating speeding to road crashes. Drivers' training (initial or continuous training as practiced in the so-called internship dedicated to get back licence points, or as an alternative to sanction), information communicated through the media and the numerous prevention campaigns have led drivers to become more aware of those risks associated with speeding. However, many drivers do not perceive the consequences of high speeding as crash risk or sanction issue for themselves (Delhomme, 2001, 2002; Finn & Bragg, 1986; Matthews & Moran, 1986). They continue to not observing speed limits even if for example in France, the implementation of speed cameras has allowed a significant behaviour change (Observatoire National Interministériel de Sécurité Routière[1]).

Actions aiming at having drivers reducing their speed by themselves, such as prevention campaigns, often lack of efficacy. Most of the time campaigns focus on the consequences of excessive speeding in terms of crash risk or sanction offences (Delhomme, Vaa, & Meyer, 2001). Yet, following the recommendations given in such messages reduces the person's freedom of behaving and could trigger reactance (Brehm, 1966). The person could wish to keep his/her freedom by rejecting the recommendations with two possible consequences: either keeping his speeding behaviour, or driving faster than before. We looked for a new support in order to increase the efficacy of prevention messages on speeding.

We wondered if the environmental protection could be this support. Our interest was focused on the different environmental consequences of driving. On the one hand, since few years various factors (e.g., pollution controls, pollution indicators, imposed speed limit during pollution peaks, or advertising on new fuel and catalysts) have contributed to establish a link between air pollution and automobile use. For example, in town one drive out of two is: shorter than 3km, generates a heavy overconsumption (+ 80% in the 1$^{st}$ km, + 50% in the 2$^{nd}$ km, etc.) and a higher pollution (carbon dioxide or $CO_2$, nitrogen oxide or NOx). More specifically, speeding increases pollutants emission in the atmosphere. Adopting a soft driving which observes speed limit will reduce the consumption and the emission of pollutants in the atmosphere[2]. On the other hand, fighting pollution is a positively perceived behaviour (Pelletier, Green-Demers, & Béland, 1999), because the noxious effects of pollutants ejected by vehicles on chemical and meteorological changes, and consequently on the mortality increase, are from now on established (Jacobson, 2008). The polluting nature of automobile use could be an issue important enough to lead drivers to observe speed limit at each drive. Our study is based on this argument.

The idea of using air pollution as a support to modify drivers' behaviour is strengthened by the results of a pilot study conducted in France in 2003 (Delhomme, Lardon, & Rodon, 2003). Sixty drivers were interviewed through semi-structured interviews. We noticed that almost all drivers only established a positive link between speeding and air pollution during air pollution peaks, when speeding is imposed. When we informed participants about this link

[1] Source : http://www2.securiteroutiere.gouv.fr/infos-ref/observatoire/index.html

[2] Source : ADEME ; http://www.ademe.fr/Midi-Pyrenees/a_4_02.html

over the year (not only during air pollution peaks), about 38% of them had intentions to observe speed limit over the whole year in order to reduce air pollution.

Will the recourse to the idea of air pollution to lead drivers to observe speed limit have the same effects on men and women? Usually, men break more often the Highway Code than women. More specifically men drive faster, which explains why they have more traffic crashes than women. These differences between men and women also exist from a judgement point of view. Women assess the Highway Code more positively than men, consider this code more important than what men do, and believe more than men that they have to observe it (Dejoy, 1992; Norris, Matthews & Raid, 2000; Turner & McClure, 2003; Waylen & McKenna, 2002; Yagil, 1998). One could expect that message effects will differ according to participants' gender, particularly on the evoked consequences about risk perception or environmental risk. A survey about drivers' environmental issues carried out in Sweden (Polk, 2003) shows that women are: more involved in environment, more critical toward automobile, more favourable to reduce or to eliminate the car's environmental impact, greater supporters of ecological issues and more inclined to ecological activities than men.

How to present, in a message, the link between speeding and air pollution in order to be effective enough to change behaviours? Messages' characteristics, their context of reception and the consecutive attitudes and/or behaviours changes have been studied (Chaiken & Trope, 1999; Chappé, Verlhiac & Meyer, 2007; Meyer & Delhomme, 2000). The thoughts listing task allows to know how the person assesses and understands the given information. Its principle consists in recording person's responses immediately after being exposed to the message (Greenwald, 1968). It allows to examine what the person/receptor has in mind just after receiving the message before the person has the time to proceed to a too elaborated processing. The quantity of gathered verbalisations as well as their valence towards the object of attitude exposed on the message (i.e., favourable or unfavourable) allow reliable predictions of the behaviour recommended on the message. Thus, if the message triggers favourable thoughts, it is more likely to be accepted (i.e., behaviour change in the expected direction) compared to when the person produces counter-arguments.

Our main objectives in the two studies reported here was to examine whether reducing air-pollution could be used as a new argument for leading drivers to abide by speed limit, and to find an effective way of presenting this information. To do this, we designed several prevention messages and compared their effects. We presented messages describing speeding as a factor that increases crash-risk (classical argument), air-pollution (new argument), or crash-risk and air-pollution (combination of these two arguments). We expected the air-pollution argument to lead to more beliefs in favor of environmental protection (e.g., greater speed-limit observance and more perceived efficacy of speed-limit observance for reducing air-pollution). Because women are more concerned about environmental issues than men, we expected the following hypotheses to be validated mainly among women: the message with the air-pollution argument will be evaluated more positively than the crash-risk message (Hypothesis 1). The air-pollution message and the crash-risk and air-pollution message will be more effective than the crash-risk message on the behavioral intention to observe speed limits (Hypothesis 2a) and on the perceived efficacy of speed-limit observance in reducing air-pollution (Hypothesis 2b).

## 2. Study 1

### 2.1. Method

#### *2.1.1. Participants & experimental design*

One hundred and seventy two students (88 women and 84 men) were volunteers to participate. The mean age was 22.2 yr. (range= 20 yr. to 26.6 yr.) and all participants had a driving licence since 3.8 yr. (range= 1.9 yr. to 8.4 yr.), with an average mileage of 12500 kilometres driven by year. Among them, 9.4% (N=16) had been penalized during the last three years, among which 60% (N=9) due to speed limit offence. Finally, 28.8% (N=49) were involved in a car accident during the last three years.

We conducted a 3 Message Type (crash risk *vs.* air pollution *vs*. crash risk and air pollution) X 2 Gender (Men *vs.* Women) between subjects factorial design.

#### *2.1.2. Questionnaire*

The beginning of the questionnaire (first page) gives the objective of the study and explains how to use 7-points Likert Scales with the example: *"Each car should be sold with at least four bunches of keys"*.
Then, a message is given on the second page of the questionnaire. The message consists of two sections: (1) the report and (2) the advice. In the report section, the message sets out the risks of speeding according to the "message type" variable: speeding brings about either "crash risk", or "air pollution", or "crash risk and air pollution". In the latest message, the two arguments are counterbalanced: half of the participants is exposed to a message linking "speeding with the accident risk then with air pollution" (order 1), and the other half is exposed a message linking "speeding with air pollution then with crash risk" (order 2).

Thereby, we drew up four versions of the questionnaire. The following example shows the report dealing with the link between speeding and air pollution: *"there is a link between drivers' speed and air pollution. The speed enhances gas/petrol/fuel consumption and gives off different pollutants (?) as carbon dioxide ($CO_2$). Despite technical progress, speed driving increases air pollution, especially the greenhouse effect"*.
Then, the message advices the participants to observe speed limit in order to reduce crash risk and/or air pollution (e.g., *"during each trip, observe speed limit in order to protect the air quality you breathe"*.)

#### *2.1.3. Independent variables*

##### *2.1.3.1. Message type and Gender*

Participants saw messages underlying "crash risk" or "air pollution" or both (i.e., "crash risk and air pollution").
Gender is taken into account in this study.

### *2.1.4. Dependent variables*

The questionnaire consists of seven different sections:

#### *2.1.4.1. Thought listing*

The thought listing task aims at examining how the participants receive and process information, for example, from prevention messages. We made a pilot study on drivers' knowledge about the link between speeding and air pollution. It revealed that drivers are aware of this link only whenever pollution levels peak. We want to know what the participants think about this information when it is given. They have to list everything that came to our mind reading the message, even if it has no matter with the message it-self.

#### *2.1.4.2. Message evaluation*

Message evaluation was measured with a 7-points Likert scale (1= "not at all" to 7 = "totally"). Participants assessed if the message was "informative", "important", "involving", and "useful".

#### *2.1.4.3. Intended speed*

Usual speed driving and speed driving they will adopt (on the town, on trunk roads, on highways, etc.) under time pressure were measured.

#### *2.1.4.4. Disadvantages of exceeding speed limit*

We measured the perceived disadvantages of exceeding speed limit. We asked the participants to assess, according to them, if exceeding speed limit "is serious", "increases air pollution", "increases the risk of offence" and "increases crash risk".

#### *2.1.4.5. Efficacy of observing speed limit*

Perceived efficacy of observing speed limit to reduce air pollution was measured for each kind of road (downtown, trunk road, highways).

#### *2.1.4.5. Demographic variables*

Participants indicated demographic variables as age, gender, length of the driving licence, average mileage in the year, number of accidents during the last three years, number of offences during the last three years.

### *2.1.5. Procedure*

Students from the University of Clermont-Ferrand are recruited in the university libraries or cafeterias to fill in a questionnaire. The questionnaire is presented as an anonymous survey aiming at better understands drivers' opinions and behaviours. It took 10 to 15 minutes to fill in.

## 2.2. Results

We conducted a content analysis on the qualitative data obtained through the thought listing task. We also carried out an ANOVA and planned comparisons on the quantitative data in order to assess the effects of the prevention messages. Data were analyzed in a 3 (Message type: underlying "crash risk" *vs.* "air pollution" *vs.* "crash risk and air pollution") X 2 (Gender: Men *vs.* Women) between subjects factor. ANOVA were completed with Tukey's test.

### *2.2.1. Thought listing task*

Data were submitted to a content analysis. From two experts' inputs, data have been ordered according to the absence *vs.* the presence of an explicit link between speeding and crash risk and/or air pollution. In every experimental condition, an equivalent percentage of participants did not explicitly link speeding and crash risk (18.6%), speeding and air pollution (11.6%), or speeding, crash risk and air pollution (10.5%). Among those who make a positive link, we encoded data in three categories: rather favourable opinion *vs.* slightly favourable opinion on this(these) link(s), and repetition of this(these) link(s) without explicit opinion.

Generally participants' opinion on the link exposed in the message changes depending on the message content, that is either on crash risk only or on air pollution only ($\chi^2_{(2)} = 7.4$, $p = .025$, $\phi = .32$), or on crash risk only or both crash risk and air pollution ($\chi^2_{(2)} = 14.5$, $p = .001$, $\phi = .36$). However, participants who had been exposed to message on air pollution only or to message on both crash risk and air pollution presented similar opinions ($\chi^2_{(2)} = 2.9$, $p = .12$). Thus, similar percentages of participants are rather favourable or slightly favourable to the message on air pollution only (39.5% and 28.9%), as well as for the message on both crash risk and air pollution (32.5% and 24.7%), whereas more participants are slightly favourable to the message about crash risk only (60%). Finally, more participants do not have/give/provide/present an explicit opinion about messages on air pollution only or on both crash risk and air pollution (respectively, 31.6% and 42.8%) compared too the message about crash risk only (14.3%).

However, differences between men and women are observed when the message is about air pollution only and also when it is about both crash risk and air pollution (respectively, $\chi^2_{(2)} = 6.14$, $p = .046$, $\phi = .4$ and $\chi^2_{(2)} = 4.9$, $p = .08$, $\phi = .25$) (Table 1). Women are more favourable than men to air pollution message, or do not have explicit opinion rather than a slightly favourable opinion ($\chi^2_{(1)} = 3.9$, $p = .047$, $\phi = .39$ and $\chi^2_{(1)} = 5.2$, $p = .022$, $\phi = .48$). Moreover, compared to men, more women do not have explicit opinion about crash risk and air pollution message, rather than a slightly favourable opinion ($\chi^2_{(1)} = 4.96$, $p = .026$, $\phi = .31$).

More specifically, more participants said that the link between speeding and air pollution is new in the air pollution message condition (40.9% of women and 37.5% of men)

than in the crash risk and air pollution condition (10% of women and 2.7% of men). In the air pollution condition, two thirds of women and one third of men agreed with this new link, whereas in the crash risk and air pollution condition, 25% of women and no men agreed with this new link.

Finally, whichever the presented message, for both men and women, all participants criticize the message content such as the information redundancy, the need of more explanations on the links between speeding, accidents and/or air pollution.

Table 1: Opinion on the link(s) according to message type (speeding-crash risk, speeding-air pollution, speeding-crash risk-air pollution) and Gender (number and percentage)

| | Message about "crash risk" | | Message about "air pollution" | | Message about "crash risk and air pollution" | |
|---|---|---|---|---|---|---|
| | Women N = 18 | Men N = 17 | Women N = 22 | Men N = 16 | Women N = 40 | Men N = 37 |
| Rather favourable opinion | 22.2% N = 4 | 29.4% N = 5 | 45.5% N = 10 | 31.2% N = 5 | 32.5% N = 13 | 32.4% N = 12 |
| Slightly favourable opinion | 61.1% N = 11 | 58.8% N = 10 | 13.6% N = 3 | 50% N = 8 | 15.0 % N = 6 | 35.2% N = 13 |
| Without explicit opinion | 16.7% N = 3 | 11.8% N = 2 | 40.9% N = 9 | 18.8% N = 3 | 52.5% N = 21 | 32.4% N = 12 |

*2.2.2. Message evaluation*

We made/created/designed an index with three of the four items used to evaluate messages (informative, involving, and useful, $\alpha = .71$), as the item "important" differed too much from the three others. Generally participants positively evaluate the message they have been exposed to ($M = 4.2$, $SD = .16$) (see table 2).

Table 2: Evaluation of the message according to Message type (speeding-crash risk, speeding-air pollution, speeding-crash risk-air pollution) and Gender (number and percentage)

| Message about « crash risk » | | Message about « air pollution » | | Message about « crash risk and air pollution | |
|---|---|---|---|---|---|
| Women M (SD) | Men M (SD) | Women M (SD) | Men M (SD) | Women M (SD) | Men M (SD) |
| 3.8 (1.4) | 3.8 (1.2) | 4.9 (1.0) | 4.1 (1.0) | 4.4 (1.2) | 4.2 (1.0) |
| $F<1$ | | $F(1,166) = 5.8$, $p = .02$ | | $F<1$ | |

A 3 (Message type) X 2 (Gender) interaction effect is observed on the message evaluation ($F$ (2,166) = 3.07, $p = .04$, $\eta^2 = .04$): only women tended to evaluate the message on air pollution only more positively than the message on crash risk ($p = .02$).

*2.2.3. Disadvantages of exceeding speed limits*

The 3 (Message type) X 2 (Gender) interaction effect on the disadvantages of exceeding speed limit is significant ($F(2,166) = 7.9$, $p = .003$, $\eta^2 = .10$). Only in the case of women, participants exposed to a message on air pollution only ($p < .01$) or to a message on

both crash risk and air pollution ($p < .01$) think that exceeding speed limits increases more air pollution than participants in "crash risk" condition (see table 3).

Table 3: Interaction effect of Message type (speeding-crash risk, speeding-air pollution, speeding-crash risk-air pollution) and Gender (number and percentage) on exceeding speed limit increases air pollution

| Message about « crash risk » | | Message about « air pollution » | | Message about « crash risk and air pollution » | |
|---|---|---|---|---|---|
| Women<br>M (SD)<br>4.4 (1.9) | Men<br>M (SD)<br>6.0 (0.9) | Women<br>M (SD)<br>6.0 (1.2) | Men<br>M (SD)<br>5.4 (1.4) | Women<br>M (SD)<br>5.9 (1.3) | Men<br>M (SD)<br>5.4 (1.6) |
| $F(1,166) = 10.8$, $p = .02$ | | $F(1,166) = 1.7$, *ns* | | $F(1,166) = 2.1$, *ns* | |

### 2.2.1. Intended speed during the next 6 months

*2.2.1.1. Intended usual speed*

A 3 (Message type) X 2 (Gender) interaction effect on intended usual speed is only observed when considering town ($F(2,166) = 4$, $p = .02$, $\eta^2 = .04$). Only in the case for men, participants in the message on crash risk only intend to drive in town at a speed lower than usual ($M = 51.3$, $SD = 4.9$) compared to those in the air pollution condition ($M$=55.7, $SD$ = 5.9) ($p = .041$).

*2.2.1.2. Speeding under time pressure*

A 3 (Message type) X 2 (Gender) interaction effect on speeding under time pressure has only been observed when considering highways ($F(2,166) = 3.2$, $p = .04$, $\eta^2 = .037$). Women in the air pollution condition intend to drive slower on highways under time pressure ($M = 129.5$, $SD = 8.3$) than women who have been exposed to messages on crash risk only ($M = 137.3$, $SD = 13.0$) ($p = .043$). As for men, no difference was observed on intended speed between the three message types conditions (see table 4).

Table 4: Interaction effect of Message type (speeding-crash risk, speeding-air pollution, speeding-crash risk-air pollution) and Gender (number and percentage) on intended speed on highways under time pressure

| Message about « crash risk » | | Message about « air pollution » | | Message about « crash risk and air pollution » | |
|---|---|---|---|---|---|
| Women<br>M (SD)<br>137.3 (13.1) | Men<br>M (SD)<br>136.2 (9.9) | Women<br>M (SD)<br>129.5 (8.3) | Men<br>M (SD)<br>141.5 (13.0) | Women<br>M (SD)<br>134.7 (10.3) | Men<br>M (SD)<br>139.2 (9.4) |
| $F(1,166) = .8$, *ns* | | $F(1,166) = 13.0$, $p = .001$ | | $F(1,166) = 4.0$, $p = .04$ | |

### 2.2.2. Perceived efficacy to observe speed limit in order to reduce air pollution

A 3 (Message type) X 2 (Gender) interaction effect on perceived efficacy to observe speed limit in order to reduce air pollution, was only observed for the highways criteria/condition

($F(2,165) = 3.6$, $p = .02$, $\eta^2 = .03$). Only for women, participants within the air pollution condition tended to report more often that observing speed limit on highways is more effective to reduce air pollution ($M = 5.17$, $SD = .88$) compared to participants in crash risk ($M = 4.20$, $SD = 1.4$) ($p = .009$) or in crash risk and air pollution conditions ($M = 4.18$, $SD = 1.3$) ($p = .03$).

## 3. Discussion Study 1

The main objective of this first study was to examine the possibility to lead drivers to reduce their speed using air pollution as an argument in our prevention messages. These messages presented speeding as a factor enhancing either crash risk, either air pollution, or both crash risk and air pollution. More effects are expected in women than in men, the former being more sensitive to environmental issues and less at risk than the latter.

The thought listing task analysis allows to examine how participants receive and process the prevention message which they have been exposed to. As expected, women are more favourable to messages on speeding and air pollution in comparison to messages on speeding, crash risk and air pollution and speeding and crash risk. For men, whichever the message, one third of them are favourable to what they have been exposed to. Moreover, when the message mentions/exposes the link between speeding and air pollution, men consider more this relation as being a novelty than women. When messages are about "air pollution", the two third of women and one third of men express their agreement with this new link.

When invited/asked to assess the messages on different dimensions, women as well as men positively assess the messages they have been presented. However women assess more positively the message on air pollution than the one on crash risk, while men have the same positive evaluation of messages, for accidents, air pollution or the link between both consequences/independently of their content/of the consequences they mentioned. In addition, women exposed to air pollution or to crash risk and air pollution messages consider that exceeding speed limit increases more air pollution when compared to those exposed to crash risk message.

Message type effects on intended speed differ according to Gender. For/Amongst men exposed to the crash risk message, the intended usual speed in town is lower than when men are exposed to the air pollution condition, whereas no effect is observed amongst//for/with women. When participants are asked about their intended speed under time pressure, women in the air pollution condition said/report they will drive slower on highways than those exposed to the crash risk condition. For men, no difference appears (i.e., equivalent intended speed) whichever the message. Finally, in the case of women only, participants in the air pollution condition tend to consider more that observing speed limit is effective to reduce air pollution than those in the crash risk and crash risk and air pollution conditions. No effect appears amongst men.

The message efficacy hypothesis is confirmed only for women. The message on air pollution appears more effective than the one on crash risk and air pollution. The first type of message provokes/triggers more favourable opinion in women than the second one, more behavioural intention (i.e., intention to adopt speeding behaviours which protect environment) and also generates a stronger belief regarding the efficacy of observing speed limits. The air pollution argument appears to be less taken into account/considered when presented with the

crash risk one. Nevertheless, at the end of the experiment, participants criticised messages' content (e.g., redundancy). As a result, messages were modified for the second research.

We elaborated more precisely our messages' content in order to enhance their efficacy in the second research. We asked ourselves about/wondered/looked at how information should be framed in messages (Meyer & Delhomme, 2000). Research conducted in the social cognition field suggests several strategies to develop effective persuasive messages (Eagly & Chaiken, 1993; Petty & Wegener, 1998; Salovey, Rothman, & Rodin, 1998). People are likely to be more influenced by a message focusing on gains associated with the adopted behaviour (positive framing) than a message focusing on losses associated with not adopting the same behaviour (negative framing; Rothman & Salovey, 1997). More precisely, people tend to avoid risks when they consider the potential gains of a behaviour (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). Generally in the risks prevention field, research shows that a positive framing is more effective than a negative one (Detweiler, Bedell, Salovey, Pronin, & Rothman, 1999; Rothman & Salovey, 1997; Wilson, Purdon, & Wallston, 1988). In the particular/specific field of driving Millar and Millar (2000) have exposed their participants to messages focusing on gains (positive framing) or on losses (negative framing). Intention to adopt safe road behaviour is higher in the positive framing condition than in the negative one for participants for whom road safety is important. Yet literature on information framing effect is not univocal as for a greater efficacy of positive framing (Meyers-Levy & Maheswaran, 2004). This lack of consistency in the framing effects is notably due to confusion in the framing operationalization.

We examine messages' effects depending on whether they highlight the positive consequences associated to the respect/observing of speed limits (positive framing) or whether they focus on the negative consequences associated with the infringement/trespass of/not observing speed limit (negative framing) in comparison with a control group (i.e., no message).

## 4. Study 2

### 4.1. Objectives

In order to enhance our messages efficacy, we manipulated framing according to the consequences of the promoted behaviour, that is to say either consequences linked/associated to observing (positive framing) or not (negative framing) speed limit. We wanted to know which message is more effective to lead drivers to observe speed limit. Furthermore, we added a control group for which no message was presented. We tested, on the one hand, the effect of the presence or the absence of a message and, on the other hand, the effect of the message type (about crash risk, air pollution or both themes).

### 4.2. Method

#### *4.2.1. Participants & experimental design*

Four hundred and fourteen drivers (202 women and 212 men) were volunteers to participate. The mean age was 34.2 yr. (range= 27.7 yr. to 43 yr.) and all participants had a driving licence since 14.7 yr. (range= 9 yr. to 23.7 yr.), with an average mileage of 12,500 kilometres driven by year. Among them, 15.2% (N=63) had been sanctioned during the last three years, among which 9% (N=37) due to speed limit offence. Finally, 16.9% (N=70) were

involved in a traffic crash during the last three years and 2.2% of them (N=9) had two traffic crashes.

We conducted a 3 Message Type (crash risk *vs.* air pollution *vs*. crash risk and air pollution) X 2 Message Framing (positive *vs.* negative) X 2 Gender (men *vs*. women) between subjects factorial design.

### *4.2.2. Questionnaire*

We tested the effects of message framing linking speeding to one of three consequences: (1) speeding and crash risk, (2) speeding and air pollution or (3) both associations. Taking into account the criticisms on/towards messages in Study 1, we gave up both the report and advice sections. We modified the messages content and added for each, in the last section, a positively or negatively framed slogan. We drew up nine versions of the questionnaire: two versions for each message on crash risk or on air pollution (positive or negative framing), four versions of the message on both crash risk and air pollution (counterbalanced order) crossed with the type of message framing (positive or negative), and finally one version without message (i.e., control group).

### *4.2.3. Independent variables*

*Message type, Message framing and Gender*

Regarding/Concerning message type, participants saw/were exposed to messages underlying either crash risk, either air pollution or both themes (i.e., crash risk and air pollution).
Concerning/As for message framings, they vary according to the consequences of observing (positive framing) or not (negative framing) speed limit. For instance, for the message on speeding and crash risk, the positive framing was such as: *"By strictly observing speed limits during each trip/drive, you protect your life and others' "*. As for the negative framing associated to this same message, the slogan was: *"By not strictly observing/By trespassing/infringing speed limit during each trip/drive, you risk your life and others'"*./you put your life and others' at risk".
Gender was also taken into account in this study.

### *4.2.4. Dependent variables*

Dependent variables are the same as in Study 1, except for the item "relevant" which replaces the item "important" in the message evaluation. We also deleted the thought listing task.

### *4.2.5. Procedure*

Professional interviewers solicited passer-by in the Lyon area to participate in an anonymous survey originated by the *Centre d'Etudes des COmportements des Français* (CECOF). Volunteers filled in the questionnaire in a room rented/hired by the interviewers.

## 4.3. Results

We conducted ANOVA on the quantitative data and planned comparisons in order to assess the effects of the prevention messages. Data were analyzed according to the two following designs:

1) without the control group, all the variables were analyzed in a 3 (Message type: underlying Crash risk *vs.* Air pollution *vs.* Crash risk and air pollution") X 2 (Framing: Positive *vs.* Negative) X 2 (Gender: Men *vs.* Women) between subjects factor ANOVA. ANOVA was completed with Tukey's test.

2) when the control group is introduced in/considered for the analysis:

Perceived disadvantages to exceed speed limit, intended speed (usual and under time pressure), and perceived efficacy to observe speed limit are analysed according to the 4 (Message type: on Crash risk *vs*. Air pollution *vs.* Crash risk and air pollution *vs.* No message) X 2 (Gender: Men *vs.* Women) experimental design, when messages are positively framed, then when they are negatively framed. ANOVA was completed with Tukey's test.

### 4.3.1. Gender, Framing and Message type effects

Experimental validation: message assessment/appraisal/evaluation

We made/designed/created an index from the four items used to evaluate messages (informative, relevant, involving, and useful, $\alpha$ = .81). As in the previous study, participants positively assess the message ($M$ = 4.8, $SD$ = 1.5) and there is a significant effect of the message type ($F(2,346) = 3.5$, $p = .03$, $\eta^2 = .02$) : participants assess more positively the message on air pollution ($M = 5.05$, $SD = .14$) compared to/than the message on crash risk ($M$ =4.53, $SD = 0.14$) ($p < .05$), whereas there is no difference between these two messages ($p > .10$) and the message mentioning both crash risk and air pollution ($M = 4.85$, $SD = 0.13$) ($p > .2$).

#### 4.3.1.1. Perceived disadvantages to exceed speed limit

No effect of the independent variables we considered was observed on the perceived disadvantages to exceed speed limit from the point of view of/as for/on what regards air pollution increase ($p > .10$)., However a significant effect of gender was observed/perceived as for what regards/concerns crash risk ($F(1,346) = 4.07$, $p = .045$, $\eta^2 = .017$). Women tended to declare/state more ($M = 6.3$, $SD = 0.2$) than men ($M = 5.98$, $SD = 0.3$) that exceeding speed limit increases crash risk.

#### 4.3.1.2 Intended speed during the next/following 6 months

##### *4.3.1.2.1. Intended usual speed*

There is a main effect of gender ($F(1,346) = 7.3$, $p = .007$, $\eta^2 = .02$), and a 3 (Message type) X 2 (Gender) interaction effect ($F(2,346) = 3.2$, $p = .045$, $\eta^2 = .02$): for/amongst women in the air pollution message condition ($M = 51.7$, $SD = 1.0$) ($p = .03$) or those who were exposed to a message illustrating/mentioning both crash risk and air pollution ($M = 51.2$, $SD = 1.3$) ($p = .04$), the intended usual speed in town is lower than amongst/for women in the crash risk message condition ($M = 55.2$, $SD = 1.3$). Moreover, concerning/regarding the intended usual

speed on highways, a main effect of gender was observed ($F(1,346) = 5.53$, $p = .02$, $\eta^2 = .015$): women presented/reported an intended usual speed lower than men ($M = 132$, $SD = 1.0$).

#### *4.3.1.2.2. Speeding under time pressure*

There is a main effect of gender on intended speeding under time pressure. In town ($F(1,346) = 5.81$, $p = .02$, $\eta^2 = .015$), men said/reported they will/an intention of driving/drive faster ($M = 60$, $SD = 1.0$) than/compared to women ($M = 58$, $SD = 0.8$). The same results were observed/gathered as for speeding under time pressure on trunk roads (Men: $M = 101$, $SD = 1.0$; Women: $M = 97$, $SD = 0.8$; $F(1,413) = 5.81$, $p = .02$, $\eta^2 = .015$), or on highways (Men: $M = 142$, $SD = 1.0$; Women: $M = 137$, $SD = 0.8$; $F(1,346) = 14.8$, $p = .001$, $\eta^2 = .04$).

A 3 (Message type) X 2 (Framing) significant interaction effect ($F(2,346) = 2.2$, $p = .002$, $\eta^2 = .04$) on intended speeding under time pressure on trunk road has been observed (see figure 1). Participants in the crash risk condition envisage driving faster when the message is negatively framed ($M = 103$, $SD = 1.5$) when compared to those who were exposed to a positively framed message ($M = 96$, $SD = 1.5$) ($p = .004$).No framing effect in both the air pollution and crash risk and air pollution conditions could be observed.

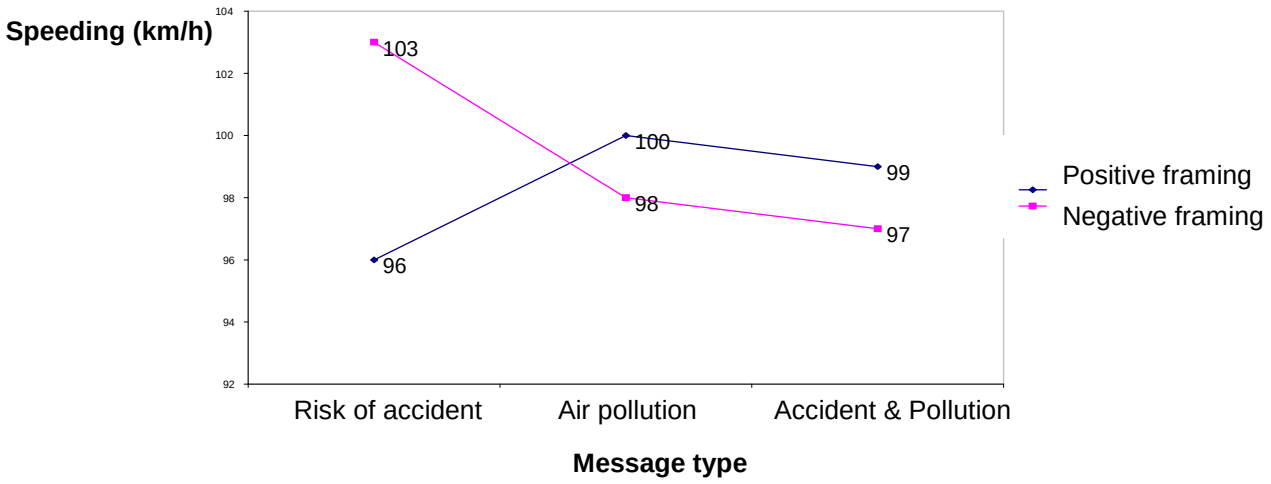


**Figure 1. Intended speeding on trunk road under time pressure**

### 4.3.1.3. Perceived efficacy to observe speed limit in order to reduce air pollution

Among all participants, 9 did not fill in the question about the perceived efficacy to observe speed limit in order to reduce air pollution. We observe a message framing effect concerning speeding in town, on trunk roads, or on highways ($\alpha$ = .77), ($F$(1,337) = 4.3, $p$ = .039, $\eta^2$ = .013): in the positive framing condition the perceived efficacy is higher **(***M* = 5.46, *SD* = 1.5) than in the negative framing one (*M* = 5.13, *SD* = 1.2). There is also a gender effect ($F$(1,337) = 8.75, $p$ = .003, $\eta^2$ = .025) which highlighted women' higher tendency/propensity compared to men' (*M* = 5.05, *SD* = 1.7) to consider perceived efficacy as being effective/efficient (*M* = 5.55, *SD* = 1.6) to reduce air pollution . Note however that the 2 (Framing) X 2 (Gender) interaction effect brings to light men' tendency to consider more the observing of speed limit as being effective to reduce air pollution when the message is positively framed compared to when exposed to a negatively framed message (see table 5).

Table 5: Perceived efficacy to observe speed limit in order to reduce air pollution according to Gender, message Framing and Message type

| | | Crash risk | Air pollution | Crash risk and air pollution |
|---|---|---|---|---|
| | | *M* (*SD*) | *M* (*SD*) | *M* (*SD*) |
| Men | Positive framing | 5.47 (1.44) | 5.36 (1.48) | 5.25 (1.31) |
| | Negative framing | 5.00 (1.51) | 4.68 (1.79) | 4.51 (1.74) |
| Women | Positive framing | 5.08 (1.65) | 5.76 (1.14) | 5.83 (1.23) |
| | Negative framing | 5.31 (1.59) | 5.66 (1.73) | 5.00 (1.74) |

### 4.3.2. Gender and experimental conditions effect (with the consideration of the control group)

Gender and experimental conditions effect depending on the message framing, on attitudes and intended speeding behaviours

**a)** Positive framing

#### 4.3.2.1. Perceived disadvantages of exceeding speed limit

With a positive framing, there is a main effect of the presence vs. absence of a message ($F$(1,239) = 4.97, $p$ = .021, $\eta^2$ =.023) on the perceived increase of air pollution. Participants exposed to a message tend to consider less than those in the control group (*M* = 2.22, *SD* = 1.5) that exceeding speed limit increases air pollution (*M* = 1.78, *SD* = 1.2) (see table 6).

Table 6: Exceeding speed limit increases air pollution depending on gender and experimental conditions

| | Crash risk | Air pollution | Crash risk and air pollution | Control group |
|---|---|---|---|---|
| | *M* (*SD*) | *M* (*SD*) | *M* (*SD*) | *M* (*SD*) |
| Men | 1.73 (1.11) | 1.82 (1.49) | 2.09 (1.32) | 2.23 (1.63) |
| Women | 1.90 (1.12) | 1.51 (1.09) | 1.64 (1.25) | 2.20 (1.52) |

As for/Regarding/For what concerns the crash risk perceived increase, we observe a main effect of gender ($F(1,239) = 4.09$, $p = .039$, $\eta^2 = .016$): women claim more than men ($M = 5.87$, $SD = 0.3$) that exceeding speed limit increases crash risk ($M = 6.1$, $SD = 0.2$).

#### 4.3.2.2. Intended speeding

##### *4.3.2.2.1. Usual speeding*

Gender has an effect on intended speeding in town ($F(1,231) = 10.27$, $p = .001$, $\eta^2 = .043$): intended speeding is higher for men ($M = 53.1$, $SD = 7.1$) than for women ($M = 49.8$, $SD = 5.8$).

There is an effect of experimental conditions linked/related/associated to the message but only when considering/concerning/to what regards intended speeding on highways ($F(3,231) = 3.13$, $p = .026$, $\eta^2 = .04$). Intended speeding of participants in the crash risk message condition is lower than the one reported within the control group. ($M = 133.1$, SD = 11.1) ($p < .05$).

##### *4.3.2.2.2. Speeding under time pressure*

We observe a gender effect concerning/on the intended speeding on the different types of roads when under time pressure. Speeding under time pressure in town is higher for men than for women (respectively, $M = 56.3$ and $M = 52.6$, $F(1,231) = 10.27$, $p = .001$, $\eta^2 = .043$). Similar results also appear for trunk road (respectively, Men: $M = 95.8$ and Women: $M = 91.9$, $F(1,231) = 4.2$, $p = .04$, $\eta^2 = .017$).

#### 4.3.2.3. Perceived efficacy of the messages

No effect is observed.

**b)** <u>Negative framing</u>

#### 4.2.2.4. Disadvantages of exceeding speed limit

There is a main gender effect ($F(1,233) = 3.99$, $p = .043$, $\eta^2 = .01$) revealing that the consideration/idea that exceeding speed limit increases crash risk is higher for /more widespread amongst women ($M = 5.9$, $SD = 0.2$) than (for) men ($M = 5.6$, $SD = 0.3$).

#### 4.2.2.5. Intended speeding

##### *4.2.2.5.1. Usual speeding*

Results highlighted a gender effect. Men' usual speeding is higher than women' in town (respectively, $M = 55.1$ and $M = 53$, $F(1,233) = 4.2$, $p = .042$, $\eta^2 = .018$) and also on highways (respectively, $M = 136.4$ et $M = 130.9$, $F(1,233) = 6.21$, $p = .01$, $\eta^2 = .027$).

There is a 4 (Message type) X 2 (Gender) interaction effect concerning highways ($F(4,233) = 5.1$, $p = .025$, $\eta^2 = .03$). In the condition referring to both crash risk and air pollution, women' intended speed is lower ($M = 125.6$, $SD = 11.2$) than the one reported by the control group ($M = 134.2$, $SD = 9.9$) ($p = .021$) (see table 7).

Table 7: intended usual speed on highways (km/h) according to/depending on gender and experimental conditions

| | Crash risk | Air pollution | Crash risk and air pollution | Control group |
|---|---|---|---|---|
| | *M* (*SD*) | *M* (*SD*) | *M* (*SD*) | *M* (*SD*) |
| Men | 133.7 (10.9) | 130.1 (13.1) | 135.3 (12.4) | 132.0 (14.0) |
| Women | 128.7 (10.8) | 128.5 (11.7) | 125.7 (11.6) | 134.3 (9.9) |

#### *4.2.2.5.2. Speeding under time pressure*

Here too gender effect is significant. Men' speeding under time pressure is higher than women' in town (respectively, $M = 56.3$ and $M = 52.6$, $F(1,233) = 10.27$, $p = .001$, $\eta^2 = .043$) and also on trunk roads (respectively, $M = 95.8$ and $M = 91.9$, $F(1,233) = 4.2$, $p = .04$, $\eta^2 = .017$).

There is a 4 (Message type) X 2 (Gender) interaction effect concerning trunk road ($F(4,233) = 5.3$, $p = .021$, $\eta^2 = .026$) and highways ($F(4,233) = 4.8$, $p = .025$, $\eta^2 = .025$). In the crash risk and air pollution condition, women' speeding under time pressure is lower for trunk road ($M = 93.2$, $SD = 8.5$) (see table 8) or highways ($M = 133.2$, $SD = 13.2$) than those reported within/by the control group ($M = 103.1$, $SD = 12.0$, & $M = 142.5$, $SD = 11.3$, respectively) ($p = .046$, & $p = .015$, respectively) (see table 9).

Table 8: intended speed under time pressure on trunk roads (km/h) according to/depending on gender and experimental conditions

| | Crash risk | Air pollution | Crash risk and air pollution | Control group |
|---|---|---|---|---|
| | *M* (*SD*) | *M* (*SD*) | *M* (*SD*) | *M* (*SD*) |
| Men | 102.8 (13.5) | 100.7 (13.7) | 100.3 (8.4) | 101.4 (14.8) |
| Women | 103.4 (12.0) | 95.0(11.0) | 93.5 (8.6) | 101.2 (11.4) |

Table 9: intended speed under time pressure on highways (km/h) according to/depending on gender and experimental conditions

| | Crash risk | Air pollution | Crash risk and air pollution | Control group |
|---|---|---|---|---|
| | *M* (*SD*) | *M* (*SD*) | *M* (*SD*) | |
| Men | 145.9 (15.8) | 142.0 (17.0) | 144.8 (13.1) | 140.2 (16.9) |
| Women | 139.1 (10.7) | 135.8 (10.0) | 133.5 (13.1) | 142.9 (11.6) |

### 4.2.2.6. Perceived efficacy to observe speed limit

There is a 4 (Message type) X 2 (Gender) (slight?) interaction effect on perceived efficacy ($F(4,233) = 2.58$, $p = .077$): the experimental conditions only have an effect in/amongst women. In the air pollution condition, women's perceived efficacy is higher ($M =$

5.6, *SD* = 1.8) than the one reported by control group women (*M* = 4.7, *SD* = 1.6) (*p* = .046) (see table 10).

Table 10: perceived efficacy to observe speed limit for the three types of road according to/depending on gender and experimental conditions

| | Crash risk | Air pollution | Crash risk and air pollution | Control group |
|---|---|---|---|---|
| | *M* (*SD*) | *M* (*SD*) | *M* (*SD*) | *M* (*SD*) |
| Men | 5.0 (1.5) | 4.6 (1.8) | 4.5 (1.7) | 4.5 (1.2) |
| Women | 5.3 (1.5) | 5.6 (1.8) | 5.5 (1.6) | 4.7 (1.6) |

## 5. Discussion Study 2

The objective in this second study was to improve messages efficacy by manipulating message framing. This has allowed to present the consequences associated with the observing or trespass/infringement of speed limit. Women and men positively assess the messages they have been presented. To be more specific/More specifically/precisely, participants assess more positively messages on air pollution than those on crash risk.

Whatever the framing, being exposed to messages appears to have little effect on the perceived disadvantages to exceed speed limit. Women in the control group condition (i.e., not exposed to messages) consider more that exceeding speed limit increases air pollution than those exposed to messages. We observe a gender effect: women consider more than men that exceeding speed limit increases crash risk. We expect that messages' effect appears in women, because/as they tend to be more sensitive to the messages than men, which/this testifies/confirms the experimental validation of this study.

As for intended speed, a gender effect is observed depending on the type of road. Whichever the framing, when under time pressure, men consider higher speeds than women on each type of road. With a positive framing, participants exposed to crash risk or crash risk and air pollution messages report lower intended usual speed on highways than control group participants. With a negative framing, only women exposed to messages mentioning both crash risk and air pollution reported lower intended usual speed on highways than control group women.

Whichever the message and the framing, men report higher intended usual speed in town than women. This gender difference also appears when considering intended usual speed on highways but only when the message presents a negative framing.

With a negative framing, women exposed to messages mentioning both crash risk and air pollution report lower intended usual speed and lower intended speed under time pressure on highways than women in the control group. Similarly/Also, women exposed to messages either on crash risk or on air pollution report lower intended speed on highways under time pressure than control group women.

Participants who were exposed to positive framing messages reported/mentioned more (often) than those exposed to negative framing messages that observing speed limit is effective to reduce air pollution. Gender difference and the experimental conditions effect are only observed when participants are exposed to messages with a negative framing. Women report more than men that observing speed limit is effective to reduce air pollution, and more specifically, women exposed to air pollution message report a higher perceived efficacy of the idea that observing speed limit reduces air pollution than women in the control group.

To sum up, the set of results of Study 2 shows a positive influence of the messages referring to both crash risk and air pollution, and to a lesser extent, of the message on crash risk only. This effect has been mainly observed on intended speeds and for what concerns women. Little effect is observed with message referring exclusively to air pollution.

## 6. General discussion

From these two empirical studies, we tested the hypothesis (according to which)/that prevention messages on air pollution (associated or not with crash risk) will be more effective/have more influence on the intentions to observe speed limit and on the perceived decrease of air pollution than a message solely based on crash risk. To our knowledge/As far as we know, no work has ever tried/attempted to test this hypothesis linking observing speed limit and air pollution. This is why we essentially referred to persuasion models.

The three messages (speeding and crash risk, or air pollution, or crash risk and air pollution) were positively assessed. Nevertheless, messages on air pollution are often assessed more positively than crash risk messages.

A support in favour of messages elaboration is observed when considering women results/answers, notably/particularly in Study 1, where no control group has been introduced/without control group. Women exposed to messages referring either to air pollution or to both crash risk and air pollution report more than women exposed to crash risk messages that exceeding speed limit increases air pollution.

Generally, messages on speeding and air pollution (with or without crash risk) trigger more intention to reduce speed or to observe speed limit than messages on crash risk. This has been particularly observed among women.

Women exposed to messages on air pollution or on both crash risk and air pollution tend to report more than women exposed to crash risk message, as well as more than men and the control group that observing speed limit is effective to reduce air pollution. This has been observed/highlighted whichever the presented message.

Intention to reduce speed or to observe speed limit is higher when messages are based on/refer to air pollution with or without mentioning crash risk. Finally, the perceived efficacy of observing speed limit to reduce air pollution is higher when messages regard/(are about) air pollution or both crash risk and air pollution.

From these results, message framing effect is not convincing And does not allow us to recommend positive or negative framing for future messages on the observing speed limit. All in all, messages on air pollution or on both crash risk and air pollution are those for which speed reducing or observing is more intended. Taking environmental issue into account in order to reduce speed or to observe speed limit is considered as an effective measure to reduce air pollution. Messages on air pollution appear to be a more efficient support than those on crash risk to lead drivers to reduce speed or to observe speed limit.

To lead drivers to participate to air pollution decrease, several ways are conceivable. Infrastructure developments as priority bus lane, or legislative measures as imposed anti-pollution control or speed limit and/or car use (car sharing, alternated traffic) during pollution peaks, can contribute to reducing car use (Fujii, Gärling, & Kitamura, 2001). Prevention programs have been specifically elaborated in order to encourage drivers to use less their car (Gardner & Abraham, 2008; Möser & Bamberg, 2008). Most of these programs are based on strategies aiming at modifying drivers' attitudes and perceptions, as for example the perceived responsibility of environmental issues and public health due to car use (Tanner, 1999; Steg et Sievers, 2000). Nevertheless, giving up car use is not always possible due to several/numerous constraints, geographic and professional being ones amongst others/due to several constraints as geographic or professional limitations for instance. Establishing and reinforcing the drivers' subjective link/association between speeding and air pollution appear to be a good way to promote safe driving behaviours such as observing speed limit and contributing to the air pollution decrease.

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