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## SCIENTIFIC MATERIALS

## Genesis, development and actuality of the Social Representation theory in more than fifty years (1961-2011 and beyond): the main paradigms and the "modelling approach"

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# Self-reported frequency and perceived difficulty of adopting eco-friendly driving behavior according to gender, age, and environmental concern

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ABSTRACT

This study considers the difficulties people have in adopting and maintaining eco-friendly driving behavior. A sample of drivers completed an online survey about eco-friendly behavior focusing on; anticipation, steady speed, low motor regime and shifting up, and others indirectly-related to the driving activity, as well as their attitudes towards environmental issues, and driving history. In general, drivers found adopting eco-friendly behavior quite easy. Drivers report anticipation behavior more frequently and perceived them as less difficult to adopt than the other changes. Inversely, low revolution motor running and the shifting up of gears were reported the least frequently and seen as the most difficult to adopt. Young and/or middle-aged drivers reported the four categories of behavior less frequently and more difficult to adopt as compared to the other age groups.

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## 1. Introduction

One way to reduce the adverse impacts of transport on environment is to encourage drivers adopt eco-friendly driving behavior. This may involve actions in relation to; their vehicles (e.g. checking tire pressures regularly, making the minimum use of air-conditioning, and avoiding overloads), their itineraries (e.g. planning itineraries in advance, changing itineraries in case of traffic congestion, and use of geographical positioning systems), and their eco-driving (e.g. operating their vehicles within an optimum revolution range by skipping and changing up gears sooner, avoiding sudden or substantial episodes of braking or acceleration, and anticipating changes in traffic conditions).

Despite the benefits that can be obtained in terms of lower fuel costs,[1] drivers have difficulties adopting and maintaining eco-driving behavior (Wahlberg, 2007), that are often associated with driving activities that are largely automated: strategical (navigation), tactical (guidance) and operational (control) (Michon, 1985). Essentially, certain types of driving behavior are more conscious (strategic and tactic) and, therefore, can be relatively easy to adopt, but inversely, other driving behavior are less conscious (tactical and operational), and it is these elements that are more difficult for individuals to change. Once this change is initiated, controlled behavior become automated or almost automated. However, learning to convert this behavior can be time consuming, difficult, and risky.

This study identifies the eco-friendly behavior drivers report as frequently adopting and the difficulties they encounter when doing so.

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[1] There is some evidence of a limited response in driver behavior to economic stimuli, e.g. Kemel et al. (2009) found that 28% of the drivers they sampled adopted fuel saving behavior as a result of fuel price rises.

## 2. Method

Our sample consists of 1243 French drivers, of which 45.5% are men. Among these drivers, 33.7% were aged between 18 and 29 years (*young drivers*), 28.7% between 30 and 44 years (*middle-aged drivers*), 26.4% between 45 and 59 years (*older drivers*) and 11.2% 60 years or more (*senior drivers*). Among participants, 24.4% had been ticketed at least once for excessive speed during the last 3 years. Moreover, participants were divided by median split into two groups based on their environmental concern measured by an *ad hoc* scale. Thus, 57.6% of them had a weak environmental concern versus a strong environmental concern for the rest of them.

A survey was administered on-line (web questionnaire hosting) to a sample of drivers resident in an urban units[2] or a large city, outside Ile-de-France. The urban units selected have at least 120,000 inhabitants from France metropolitan, or 44 large cities. Two urban units are multi-polarized: Marseille Aix-en-Provence, Douai and Lens. The web-link was sent by mail to participants from a custom online access panel[3] belonging to a polling company between July, 23rd and August, 3rd 2010. The general instructions mentioned that the study was assessing various aspects of driving behavior to help understand better the driving habits of motorists. Respondents were invited to carefully read the questions before answering. They received incentives for participating in the survey. The approximate time taken to fill in the questionnaire was 17 min.

The questionnaire was divided to cover: eco-friendly behavior measures (self-reported frequency and perceived difficulty), environmental concerns, and socio-demographical and driving history measures. For the first two sections, all items were coded on a scale from one to five.

We consider 16 eco-friendly diver behavior features organized into four categories, each of four items; anticipation (e.g. lightening the pressure on the acceleration pedal when approaching orange/amber traffic lights or stops); adopting the use of higher rears (e.g. using the engine to slow down rather than the brake); driving at a steady speed (e.g. avoidance of sudden acceleration/braking); other eco-behavior driving attributes (e.g. limited use of air-conditioning). Of these, riving at low engine revolutions behavior involves the least overtly conscious and most automated driving regarding these actions, we recorded the self-reported frequency (never/always, $\alpha = 0.82$) and perceived difficulty (very difficult/very easy, $\alpha = 0.81$).

Environmental concern was measured using an *ad hoc* nine items scale, e.g., "I am searching for information concerning the environmental protection", strongly disagree/strongly agree. Higher scores indicated a stronger concern towards environmental issues. Socio-demographic and driving history was reflected by age (from 18 to 72 years old), gender, geographical background, professional status mileage, years since having obtained a driving license, and the number of crashes in the previous 3 years.

## 3. Results

A strongly positive correlation of 65% between self-reported frequency and perceived difficulty is found from the data, supporting the idea that the eco-friendly behavior perceived as easy to adopt were more frequently reported. Age, gender, and environmental concern effects on self-reported frequency and perceived difficulty of eco-friendly behavior are also found (Table 1).

Older women, and strongly environmentally oriented drivers reported eco-friendly behavior more frequently and perceived it as easier to adopt than the middle-aged as well as young males, and those with a limited orientation to environmental actions. Moreover, an interaction effect between age and environmental concern on perceived difficulty of adopting eco-friendly behavior is found, and among drives with a weaker environmentally-orientation, the young ones perceived eco-friendly behavior as more difficult to adopt than middle-aged, older, and senior drivers. No age effect is found among the strongly environmentally oriented (Table 2).

Differences emerge between the various categories of eco-friendly behavior in regard to self-reported frequency and perceived difficulty. Drivers reported anticipation more frequently and perceived it less difficult to adopt than steady speed, other behavior indirectly-related to the driving activity, and low regime motor and shifting up.

Anticipating traffic events and more gradual deceleration acceleration at traffic lights and stops are the most frequently reported behavior and also are perceived as the easiest to adopt. Inversely, the less frequently reported behavior are making more fuel efficient use of gear selection and turning off the engine at extended stops (more than 30 s); these are actions that are the most difficult to adopt. Age, gender, and environmental concern had an effect on reported frequency of anticipatory actions, with middle-aged, older as well as senior, women and strongly environmentally oriented people reporting them more frequently than the young, men in general, and those with a weak environmentally orientation. Middle-aged, older, as well as senior and strongly environmentally oriented drivers also perceive anticipatory behavior as less difficult to adopt than young and weakly environmentally oriented individuals. Moreover, an interaction effect between age and environmental concern on perceived difficulty is found. There is, however, no significant effect among strongly environmentally oriented

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[2] The term of "urban unit" is used to covers concepts of urban agglomerations and isolated towns: a common or a group of communities that in their territories have a built up area of at least 2000 inhabitants where no residence is further than 200 m from a neighbor.

[3] A custom online panel (Internet access panel) is a group of pre-screened respondents who have expressed a willingness to participate in surveys and/or customer feedback sessions. The panel is also known as a customer advisory panel, proprietary panel or an online research panel. Respondents become "panelists" by completing a profiling questionnaire. The data collected includes demographics, characteristics and media habits, which provides a basis for future survey participation.

**Table 1**
The means and standard deviations of self-reported frequency and perceived difficulty of eco-friendly behavior.

| | Gender | | | | Age | | | | | | | | | | Environmental concern | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Men | | Women | | 18–29 | | 30–44 | | 45–59 | | 60+ | | | | Weak | | Strong | |
| | M | SD | M | SD | M | SD | M | SD | M | SD | M | SD | | | M | SD | M | SD |
| *Self-perceived frequency* | | | | | | | | | | | | | | | | | | |
| Global score | 14.95 | 0.08 | 15.19 | 0.08 | 14.23 | 0.09 | 14.78 | 0.10 | 15.45 | 0.10 | 15.84 | 0.16 | | | 14.51 | 0.08 | 15.64 | 0.08 |
| Anticipation | 4.21 | 0.02 | 4.29 | 0.02 | 4.05 | 0.03 | 4.22 | 0.03 | 4.32 | 0.03 | 4.40 | 0.05 | | | 4.13 | 0.02 | 4.37 | 0.02 |
| Steady speed | 3.91 | 0.03 | 4.14 | 0.03 | 3.73 | 0.03 | 3.97 | 0.03 | 4.17 | 0.03 | 4.24 | 0.03 | | | 3.87 | 0.03 | 4.18 | 0.03 |
| Other eco-behavior | 3.75 | 0.03 | 4.11 | 0.03 | 3.56 | 0.03 | 3.62 | 0.03 | 3.82 | 0.03 | 3.98 | 0.05 | | | 3.57 | 0.03 | 3.92 | 0.03 |
| Low motor regime and shifting up | 3.11 | 0.03 | 2.96 | 0.03 | 2.88 | 0.03 | 2.96 | 0.03 | 3.12 | 0.04 | 3.21 | 0.06 | | | 2.93 | 0.03 | 3.15 | 0.03 |
| *Perceived difficulty* | | | | | | | | | | | | | | | | | | |
| Global score | 16.12 | 0.10 | 16.15 | 0.11 | 16.22 | 0.11 | 16.80 | 0.11 | 17.39 | 0.12 | 17.53 | 0.19 | | | 16.45 | 0.09 | 17.52 | 0.09 |
| Anticipation | 3.80 | 0.02 | 3.75 | 0.02 | 4.39 | 0.03 | 4.57 | 0.03 | 4.67 | 0.03 | 4.64 | 0.05 | | | 4.44 | 0.02 | 4.66 | 0.02 |
| Steady speed | 4.29 | 0.02 | 4.46 | 0.03 | 4.09 | 0.03 | 4.35 | 0.03 | 4.50 | 0.03 | 4.55 | 0.05 | | | 4.26 | 0.02 | 4.49 | 0.03 |
| Other eco-behavior | 4.30 | 0.02 | 4.28 | 0.02 | 4.02 | 0.03 | 4.07 | 0.03 | 4.24 | 0.04 | 4.32 | 0.06 | | | 4.01 | 0.03 | 4.31 | 0.03 |
| Low motor regime and shifting up | 3.93 | 0.03 | 3.83 | 0.03 | 3.17 | 0.03 | 3.80 | 0.04 | 4.02 | 0.04 | 4.00 | 0.06 | | | 3.73 | 0.03 | 4.04 | 0.03 |

**Table 2**
Anova tests and effect size for self-reported frequency and perceived difficulty by age, gender, and environmental concern.

| | Age | | Gender | | Environmental concern | |
| --- | --- | --- | --- | --- | --- | --- |
| | F | Eta$^2$ | F | Eta$^2$ | F | Eta$^2$ |
| *Self-perceived frequency* | | | | | | |
| Global score | 35.05*** | 0.07 | 3.74* | 0.06 | 84.96*** | 0.06 |
| Anticipation | 17.03*** | 0.04 | 4.57* | 0.04 | 41.01*** | 0.03 |
| Steady speed | 32.10*** | 0.07 | 27.18*** | 0.02 | 47.96*** | 0.03 |
| Other eco-behavior | 18.46*** | 0.04 | ns. | ns. | 69.2*** | 0.05 |
| Low motor regime and shifting up | 10.86*** | 0.02 | 10.83*** | 0.09 | 25.21** | 0.02 |
| *Perceived difficulty* | | | | | | |
| Global score | 21.45*** | 0.05 | ns. | ns. | 58.77*** | 0.04 |
| Anticipation | 10.82*** | 0.02 | ns. | ns. | 32.63*** | 0.02 |
| Steady speed | 29.22*** | 0.06 | 16.53*** | 0.01 | 31.17*** | 0.02 |
| Other eco-behavior | 10.21*** | 0.02 | ns. | ns. | 45.41*** | 0.03 |
| Low motor regime and shifting up | 11.97*** | 0.02 | 4.34* | 0.03 | 41.32*** | 0.03 |

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

drivers, although among the weakly environmentally oriented, the youngest group perceived eco-friendly behavior as more difficult to adopt than others.

There are slight differences in behavior between the eco-friendly anticipatory approaches of looking in front to adjust to changing traffic conditions, and more gradual slowing when approach orange traffic lights or stop signs, and when going down hill. Drivers report looking forward more frequently, and had little difficulty adopting a lighter approach to their use of the accelerator. Age, gender, and environmental concerns influenced self-reported frequency and the perceived difficulty of driving at a steady speed. Older as well as senior, women, and strongly environmentally oriented drivers reported steady speed more frequently and easier to adopt than young as well as middle-aged, men, and weakly environmentally oriented drivers.

Moreover, an interaction effect between age and environmental concern is found regarding the perceived difficulty of driving at a steady speed; there was no effect among strongly environmentally oriented drivers but the weakly environmentally oriented, and the young perceived eco-friendly behavior was seen as more difficult to adopt to than the other age groups.

The data show differences between the forms of eco-friendly behavior – avoiding sudden acceleration/braking, complying with speed limits or time headways, and avoiding lane changes between vehicles – with steady speed driving being perceived as proving particularly. Drivers reported avoiding sudden accelerations/braking more frequently than complying with time headway, avoiding zigzagging between vehicles, and complying with speed limits. They are also perceived avoiding zigzagging between vehicles as less difficult than avoiding sudden accelerations/braking, complying with time headway, and speed limits.

Age and environmental concern influenced self-reported frequency and perceived difficulty of other, indirectly related, eco-driving behavior with older as well as senior and strongly environmentally oriented drivers reporting it more frequently and as being easier to adopt than young as well as middle-aged and weakly environmentally oriented drivers. Our result also showed differences in the actions of checking tire pressures regularly, using of air-conditioning and heating, changing itineraries, and not using vehicles for short trips. Drivers reported changing the itinerary when there was traffic congestion more frequently than they did the other actions. They also perceived checking tire pressures as less difficult to adopt than changing their itineraries in case of traffic congestion, avoiding the use of their vehicle for short trips and in limiting the use of air-conditioning and heating.

Age, gender, and environmental concern regarding affects drivers' approaches to acceleration and shifting use, with older people, senior, men, and the strongly environmentally oriented drivers doing it more often and finding it perceived it easier to adapt to than the young, middle-aged, women, and those less environmentally oriented. The analysis also finds differences in the use the engine breaking and of the accelerator, using less fuel consuming gears, and turning off the engine when stopped for a period. Drivers reported using the engine to brake more frequently and perceived it easier to adopt than a lighter touch on the accelerator, turning off the engine at stops, or maintaining low geared driving.

## 4. Conclusions

Overall, the sample of French drivers reported adopting eco-friendly behavior frequently and perceived many of the necessary actions easy to adopt. Of the eco-friendly actions investigated, the most frequently self-reported behavior related to anticipation of changing traffic conditions, followed by steady speed driving, the light use of the accelerator, and fuel efficient gear selection; the first being a form of anticipatory behavior, and the last group conscious driving habits that more difficult to change.

Age, gender, and environmental concern are found to influence the self-reported frequency of actions, and the perceived difficulty of anticipation, driving at a steady speed, conservative use of the accelerator, and gear shifting. In general, older and more senior women, and strongly environmentally oriented drivers reported eco-friendly driving behavior more frequently and perceived it as less difficult to adopt than the young, middle-aged, men and the weakly environmentally oriented. We found that anticipation and a steady cruising speed were reported less and were actions the young find more difficult to adopt compared to other groups.

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