SUBJECTVE RISKS AND TRAFFIC VIOLATIONS:
FIRST RESULTS OF AN EXPERIMENTAL STUDY IN DRIVING SIMULATOR

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Abstract

Much psychological research was conducted on how the concept of subjective risk could explain and predict the behavior of road user. The difficulty with attempting to measure drivers' subjective feeling of risk is that it cannot be measured directly. A method to quantify this feeling is to analyze the risk taken by drivers when they drive. The aim of this paper is to categorize the situations in which occur traffic violations and to precise the subjective risks perceived by drivers. We conducted an experiment in the driving simulator of LAMIH department with 44 drivers. Our results show that the number of voluntarily traffic violations is correlated with the driving style and with the fact that the drivers who didn't respect voluntarily the rules consider the situation more risky but also as safety as the drivers who respected the rules. This result argues that they didn't perceive the real risk.

Keywords: Driver behavior, traffic violation, risk assessment

1. Introduction

The European Transport Safety Council considers that road transport is the most dangerous means of transport (European Transport Safety Council, 1995). Significant progress has been made in upgrading the safety characteristics of both vehicles and roadway environment. Many of implemented improvements have been achieved and have decreased rates of road accidents. But while road users are only one component in the environment – driver – vehicle system, they nevertheless determine to a very large degree the level of safety that is achieved on the road. That is why, some road safety practitioners are now encouraging increased emphasis to issues relating on driver behavior.

Naatanen and Summala (1976) put forward the proposition that, with regard to safe driving behavior, the critical determinants of the road user's behavior are motivational. In this view, the road user's behavior must be seen as reflecting a balance between personal motives (thrills, speed, etc.) and the subjective risk of being involved in a crash. The main point of this view is the argument that drivers can perceive subjective risks, which are not objective risks. The difference between subjective and real risks evaluation could explain misunderstanding and driving errors, which, if not resolve at time, could produce crash conditions. Much psychological research has been conducted on how this concept of subjective risk could explain and predict the behavior of road user. The difficulty with attempting to measure drivers' subjective feeling of risk is that it cannot be measured directly. To solve this problem, two theoretical approaches to the concept of subjective risk are outlined by the literature. The homeostasis risk model argues that road users always operate at the maximum level of risk that they are prepared to accept. The level of risk accepted by the driver is determined by

cognitive and motivational states (Grey, Triggs and Haworth, 1989). This theory is called "risk compensation" (Wilde, 1982). The zero risk theory argues that the driver is not normally concerned by risks, and that driving must be seen as a habitual activity based on largely automatic control of safety margins. Naatanen and Summala (1976) underscored the importance of personal experience for people to learn and evaluate risks. Svenson, Fischhoff and MacGregor (1985) suggest that this personal driving experience would signify that the driving task does not entail feelings of subjective risk until a situation, that requires actions to avoid a collision, arises.

Another method to quantify the drivers' subjective feeling of risk is to analyze the risk taken by drivers when they drive. This method was applied in some domains of decision-making field. In this particular field, a kind of particular violation, the Barrier Removal (BR), has been aware recently in human reliability analysis (HRA) domain. Sometimes, users voluntarily do not respect the barriers specified by designers to protect the system from the negative consequences of errors or failures. This phenomenon has been observed in various process industry fields (Vanderhaegen, Polet, 2000). Polet, Vanderhaegen, Millot et al (2001) defined a model of the removal of a given barrier (the BCD model), which integrates three distinct attributes (the immediate cost of removal, the expected benefit and the potential deficit (the potential risk of bad consequence of the removal). This model considers both the positive and the negative consequences of such a human behavior.

The two main questions that we try to answer in our research program are, firstly, which relation exists between subjective risks and violations ; secondly, if and how the BCD model in Human Decision Making and Control field could explain and predict road violations. This paper presents the first part of the research program. Its aim is to categorize the situations in which occur violations (barrier removal) and to precise the subjective risks perceived.

2. Method

In the realistic and safe environment of the driving simulator (SHERPA, LAMIH), we defined a realistic 40km long itinerary with two sections: rural section and motorway section. In this run, we defined 7 type of situations from the accident mechanisms literature (van Elslande, 2000; McKenna, 1982): (1) STOP situation; (2) intersection with the French rule *Priorité-à-droite* (give-way-to-the right rule); (3) situation with solid white line in the road; (4) and (5) situations of route in a straight line during few kilometers, in rural roads and motorway (straight line where the drivers could potentially exceed the speed limit); (6) and (7) situations of route with curves in rural roads and motorway (where the drivers could not respect the "keep to the right" rule). Few situations were presented two times, so, we obtained 10 situations.

Each driver met three stages: questionnaire, driving and debriefing stages. The data recorded and analyzed were (1) objective measures of actions of drivers in the vehicle (for example on the brake pedal), (2) some questionnaires on the habits and driving attitudes before the experimental run and on mental load during the experimental situations, and (3) video and audio data recording. The video data were recorded during driving stages with 4 inboard cameras (global position of driver, position of hands, front and back views). The audio data were recorded during the questionnaires and the driving stages. The audio and video data were used during the debriefing stage. In this late stage, we showed to each driver few seconds of the video tape corresponding to the situations met during the driving stage and we asked the driver to describe the information he or she took into account in the situation. In the case of intersection, we showed also few seconds of the video just after the cross signal.

44 drivers (27.3 years ±5.3), having all driving licenses (8.1 years ±5.1), completed the tests voluntarily; 30 were undergraduate students and 14 were in paid employments.

3. Results

For the 10 situations analyzed, each driver can respect or not the rules, and so removes a barrier. We analyzed the video, the audio and the vehicle data of 440 situations (44 participants * 10 situations). We had to remove 31 situations because of technical and other problems. So we analyzed 409 situations (average 9.3 ± 0.6 situations / participant) and distinguished four possibilities of violation with respect to (A) the result of the actions (violation / not violation), identified by the means of the objective measures, and (B) the intentional characteristics of the behavior (Voluntarily / Involuntarily), identified from the verbalization of the subjects. So, four situations can appear (cf. table 1).

Table 1: Four types of violation according to the result of the actions (violation / not violation) and to the intentionality of the behavior. Number and percentage of each of them (N=409).

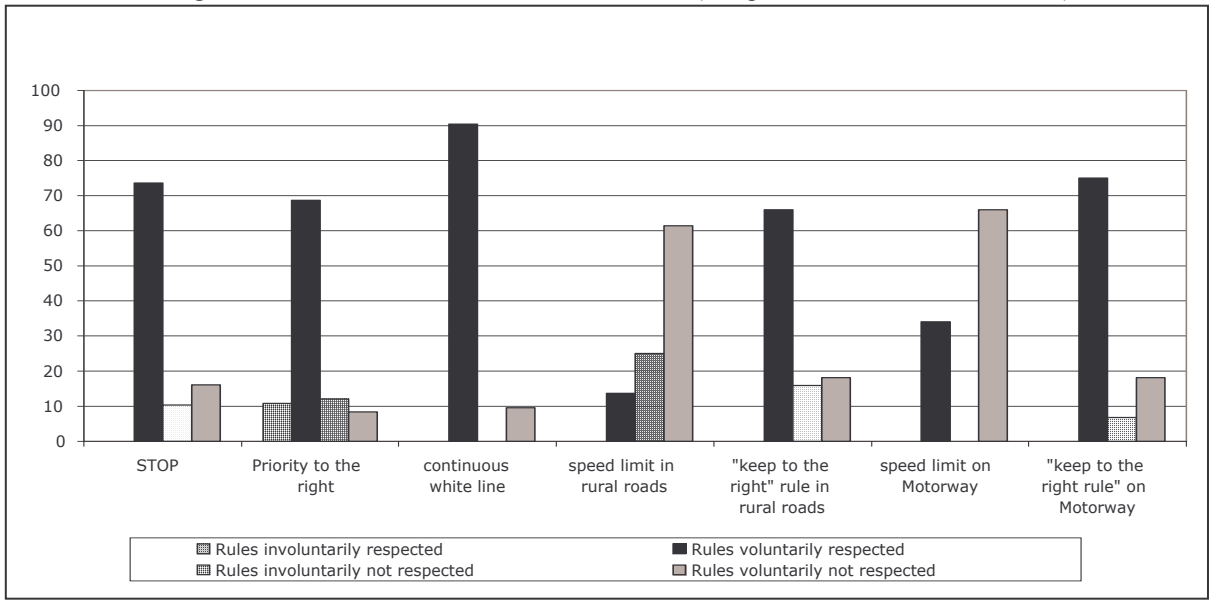
(B) Intentional characteristics of the behavior	**(A) Existence of a violation**	
	Violation	**No violation**
Voluntarily	(1) Rules voluntarily not respected	(2) Rules voluntarily respected
Number	99 (24,2%)	261 (63,8%)
No Voluntarily	(3) Rules involuntarily not respected	(4) Rules involuntarily respected
Number	40 (9,8 %)	9 (2,2 %)

The situations “1” and “2” are identified when the participant clearly explains that he or she has voluntarily respected or violated the rule. The situations “3” appear when the participant’s intention is to respect the rule, but it is not possible because of the experimental condition (e.g. the lack of sensorial feedbacks due to the simulator). The situations “4” appear when the driver respects the traffic rules, but without the intention to respect them (e.g. “I have don’t saw the road signs”). The table 1 shows that, in almost 2/3 of the situations analyzed, the drivers respected voluntarily the rules. In only 1/3 of the situations, drivers do not respect the rules. If we ignore the situations of rules involuntary not respected, in almost 1/4 of the situations, drivers do not respect voluntarily the rules.

The figure 1 proves that the respect of road rules depends on the situation. Two categories of situations can be set: (1) The speed limit rule (on rural road and motorway): in more than 60% of the situations, the drivers do not respect the rules voluntary on rural road and on motorway. (2) The other rules: in more than 60% of the situations, the driver do respect the rules voluntary. The situation of solid white line is specific: In 90% of the situations, deliberately the drivers do not cross the solid white line.

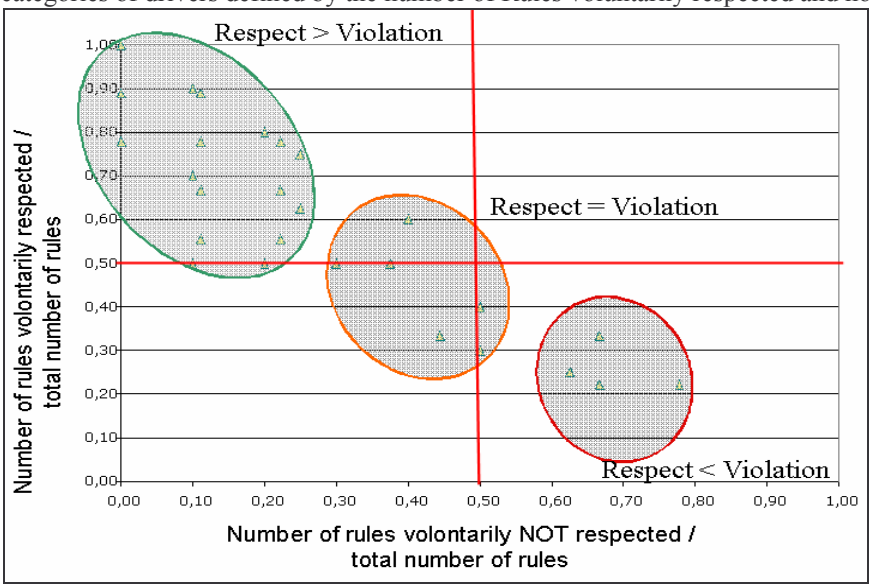
Then, in order to precise the result relative to the removal of speed barriers, we analyzed the maximal speed reached by drivers on rural and motorways sections. The results show that the speed limit is more exceeded in rural sections: the average exceed is 15 ± 2 km/h in motorways section and 25 ± 2 km/h on rural section. An ANOVA test confirms this result ($F(1; 76) = 8.334$; $p<0.01$). In particular, in rural sections, more than 1/3 of the participants drive between 21 and 30 km/h beyond the speed limit (90 km/h), whereas they are only 1/10 on motorways sections (limited to 130 km/h).

Figure 1: Percent of violations for each situation (compared to all the situations met)



The figure 1 also shows three categories of drivers if we compare the number of Rules voluntarily respected and voluntarily not respected. In order to compare the drivers, we calculate two ratios taking into account the number of situations met by each driver (figure 2).

Figure 2: 3 categories of drivers defined by the number of Rules voluntarily respected and not respected.



The figure 2 shows than some drivers violate more rules than others. The first group of drivers (32 drivers) respects more rules than it violates. The second group (8) respects as more rules as it violates. The third group (4) violates more rules than it respects.

We wanted to determine the characteristics of these drivers. Our first results show a positive correlation between the number of voluntarily traffic violations and the driving style defined by the participants themselves in a questionnaire (continuum value between nervous and economic style) ($r = 0.529$; $p < 0.0005$). This driving style value is also correlated with other questions in our questionnaires: in particular, the preference for quick acceleration ($r=0.646$; $p<0.0001$) and the feel good for driving dangerously ($r=0.676$; $p<0.0001$).

If we analyze the detail of the correlation between violation and driving style in function of the situation, our results show a correlation between the driving style and the number of

deliberate traffic violations in the case of Stop ($r=0.324$; $p<0.05$) and white line ($r=0.439$; $p<0.005$), but no significant correlation in the case of give-way-to-the right situation. We investigated the difference between these three types of situations to understand the reasons of this particularity. From the video and audio data, we coded if the driver knew the good rule to apply or not before and in the situation. 1/5 of the participants did not know the good rule to apply at the approach of give-way-to-the right intersection, and in the intersection still 1/7 of the participants do not know the good rule to apply. Only 1/10 of participants do not know the good rule to apply at the approach of Stop, and, in the intersection, all the participants know the good rule to apply. For the white line, all the participants know the good rule to apply in the situation. A Chi-square test reveals an effect of the type of situation type on the correct understanding of the rules to apply (yes / no): DDL=2; $p<0.001$. The give-way-to-the right situation is the most misunderstanding situation, the white line situation is the most understandable situation, and the stop situation is between both.

We wanted to know if the subjective perception of risk and security in the situation depends on the type of violation. An ANOVA test demonstrates that the type of violation has an effect on the subjective perception of risk ($F(2, 135) = 3.904$; $p<0.05$). The drivers, which have respected voluntarily the rules, find the situation less risked (2.7 ± 0.3) than the drivers who have not respected the rules voluntarily (4.2 ± 0.7) and involuntarily (4.7 ± 1.0). There is not post-hoc effect between the drivers who have not respected the rules voluntarily and those who did it involuntarily. So, the drivers who didn't respect the rules consider the situation more risky then the drivers who respected. An ANOVA test shows also that the type of violation has an effect on the subjective perception of security ($F(2, 135) = 3.904$; $p < 0.05$). The drivers which have respected voluntarily the rules find the situation more safety (8.0 ± 0.2) than the drivers who have not respected the rules voluntarily (7.5 ± 0.6) and involuntarily (6.2 ± 0.9). But there is no significant post-hoc effect between the drivers who have respected the rules and those who didn't respect voluntarily the rules. So, these drivers have the same perception of safety. By comparison with the results we obtained, we can assume that the drivers who didn't voluntarily respect the rules consider their behavior as wholly safety as the drivers who respect voluntarily the rules. We can also assume that the risk in the situation they mentioned is a hypothetical risk, not a risk they really took into account in their decision.

4. Conclusion - Discussion

We have presented in this paper the first results of our actual research focusing on a psychological model of driver' risk perception. To estimate this perception, we conducted an experiment in driving simulator where 44 participants drove in an experimental itinerary with specifics rules to apply. They also filled in some questionnaires on their habits and driving attitudes and on their understanding of the situations they met.

Results show that the majority of drivers respect road rules, except the speed limit. Which is remarkable is the result that the speed limits are more exceeded on rural section than on motorways sections. We assume that this difference could be correlated with the risk of apprehension for traffic violations, more significant on motorways than on rural roads.

We also show that the number of voluntarily traffic violations is positive correlated with the nervous driving style. The drivers who voluntary violate the traffic rules search the sensations obtained by driving dangerously and intense sensations (intense acceleration, brief braking…). We now analyze the data to precise these results. Our aim is to know if the violations are realized voluntary by pleasure (to drive dangerously) or if they are an indirect and poorly consequence of their nervous driving style and of their desire to operate promptly.

They wish not to loose time, even if this time objectively should give them a better understanding of other user's behaviors and traffic signals.

This "loose of time" would be helpful, in particular, to understand the situations risky and poorly understood by drivers. It is the case of the give-way-to-the right situations. Our results show that these situations are more misapprehended than the solid white line and stop situations: still 1/7 of the drivers do not know the good rule to apply in give-way-to-the right intersections. This misunderstanding added with a potential nervous driving is the preconditions of accident. We now analyze the data to precise the potential correlation between the number and gravity of accidents occurred in driving simulator and the driving style.

The amount of drivers who violate traffic rules put forward the proposition of Svenson, Fischhoff and MacGregor (1985) that the driving task does not entail feelings of subjective risk until a situation that requires actions to avoid a collision arises.

We continue our actual research to outline the existence of criteria, which could be taken into account by drivers to evaluate the benefice, cost and deficit of their decision-making (violation or not). These criteria will be the first step of a mathematical model, which could estimate the drivers' subjective feeling of risk, predict the violations, and allow an automatic system being implemented which could act to avoid them before they occur.

5. References

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