Gaps between rules and uses of the road

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Abstract. Regarding the high rate of transgressions of the Highway Code, the paper is about how do road users agree to be exposed to such risks? We consider that this issue must be addressed within an "ergonomic" point of view: there is a gap between prescribed and effective task and the non-respect of the road safety laws has to be analyzed in those terms. Data show for instance that the more people drive, the less people are able to recall the meaning of road signs. We hypothesize that acquiring expertise in driving means taking the whole driving situation into account. As a consequence, the context of the task at hand then becomes more important than the formal meaning of a road sign. We propose the use of contextual graphs to represent the different possible actions regarding the different contexts in which the driver is involved. It appears then that the driving task can be assimilated to a contextualization of the Highway Code prescribed procedures.

Introduction

Let's recall first some statistics about road crashes in France: in the year 2003, 90 220 corporal accidents were recorded by the observatory of the road safety, including 5 731 persons killed. Infringements to the laws of road safety appear as a frequent phenomenon and relationship between infringement and accident has often been pointed out [1]. . With a so high rate of transgression in the driving activity and a so high rate of road crashes, how can we explain the road users tolerance to the hazard they are exposed to? Is it a problem of insubordination or an inadequacy of laws prescribed to road users?

Our study tries to explain some of these transgressions as being involuntary disrespects of laws. We postulate the existence of *involuntary transgressions that are caused by erroneous interpretations of road signs. Such erroneous interpretations that cause highway code transgressions appear when the driving situation context influence the driver decision making to an action that is not the one prescribed by the*

law. Our hypothesis is that road signs transgressions come under a problem of discrepancy between laws and uses. More particularly, we consider that the observed gap between the prescribed tasks and the practiced uses is analyzable in terms of context. Context might be the key word to explain why there is no match between the prescribed and the effective practices of system users in general.

Procedures versus practices

Road signs aims at ensuring safety measures and regulating road traffic [2]. However, road users have generally a different viewpoint. They often consider road signs like constraints (speed limits, actions prescriptions, etc.) described by law articles, and, in some cases, useless overloads.

The violation of these constraints leads to juridical sanctions with more or less dramatic consequences, but it clearly appears that their transgression is very frequent. How can we explain that phenomenon while lives are threatened? Classically, some hypothesis are proposed: insufficiency of the juridical sanctions, lack of knowledge of laws, bad appreciation of risk, impossibility to respect the law (when the infrastructure is inadequate) or inadequacy of laws in some of the contexts in which drivers are involved. For example, a given road sign may appear in different contexts that imply different interpretations for the user that is obliged to grasp a number of contextual elements for attempting a correct interpretation of the road sign. Several of these hypotheses, maybe all of them, are useful to understand laws transgressions. Nevertheless, we chose to turn our attention to the driver's decision-making in situation, notably because we think that it is an innovative point of view. Our approach leads to an interesting practical range in the domain of road safety given that it is easier to intervene on the device than on the user's behavior. Finally, we think that driver's decision-making in context intervenes upstream with regard to the other accounts of Highway Code transgressions.

According to Allen, Lunenfeld & Alexander [3], the information retrieval made by drivers depends on the activity at hand. The authors distinguish three levels of activity in the driving task. First, at the lower level, the activity corresponds to tasks of control and regulation of the speed or the trajectory. At the intermediate level above, one finds the tasks of adaptation of the trajectory to specific states of the traffic. At the upper level, the activity is oriented towards a global organization of planning and spatial orientation of the trajectory. Thus, there is a relationship between the objective corresponding to one of these sub-tasks and the information retrieval made by the driver. Thus, the processing of information depends on the task at hand. An information could be perceived but not taken into account by the driver because s/he can not connect this information with the task at hand: the information is not related at the level of the activity at hand. For instance, a "*Do not pass*" road sign would not be taken into account by a driver that has not to the goal of passing cars. On the opposite, it could be taken into account by a visitor of other country looking for their way, as advertised: "The road sign *Do Not Pass* means *No overtaking*, or in other words *Do not pass other vehicles*. It does not mean *No entry*, nor *Do not proceed beyond this*

point, as visitors from other countries might perhaps think". Does this mean that visitors from other countries that understand the "*Do not pass*" road sign as '"*No entry*" will pass cars when forbidden by the road sign?

Our proposal is based on the distinction between on the one hand, the logic of functioning (or the prescribed task, here the laws) and on the other hand, the logic of use (or the effective task, the observed behavior). This is a useful distinction in the different domains where a technical device is used [4, 5], that we use for understanding drivers decision making in situation.

The resolution of incidents in the Parisian subway is a good example of this discrepancy. The RATP (French company of urban public transportation) propose a whole set of procedures (built on observed practices and decontextualized for covering a large class of problem) to operators but we state that they tend to tailor (and transform) official procedures according to the occurring context [6] and, finally, there are as many practices as contexts and operators. Why do they choose to plan their actions real time (which seems more expensive, in terms of cognitive investment) whereas they dispose of many official procedures? Indeed, procedures are not perfectly adapted to the concrete situations, because they are averaged, that impose to operators to develop sub-optimal strategies of problem solving. Real time planning allows an adaptation to the whole situation (which includes the action context) and its potential evolution.

According to this example, the gap between prescribed and effective tasks is not due to an imperfect knowledge of the laws or a will of transgression but because of a certain expertise level which leads to a better use of the device.

Apprehending the rules

A road user faces perpetually a jungle of road signs. There are about 400 official European road signs. They are not independent but respect a grammar [7], [8]. Each road sign can be divided into primitives: the shape (circle, triangle or square), the frame and font color, the icon in the centre of the sign; each element has its own meaning. The combination of those different elements allows a great amount of possible messages.
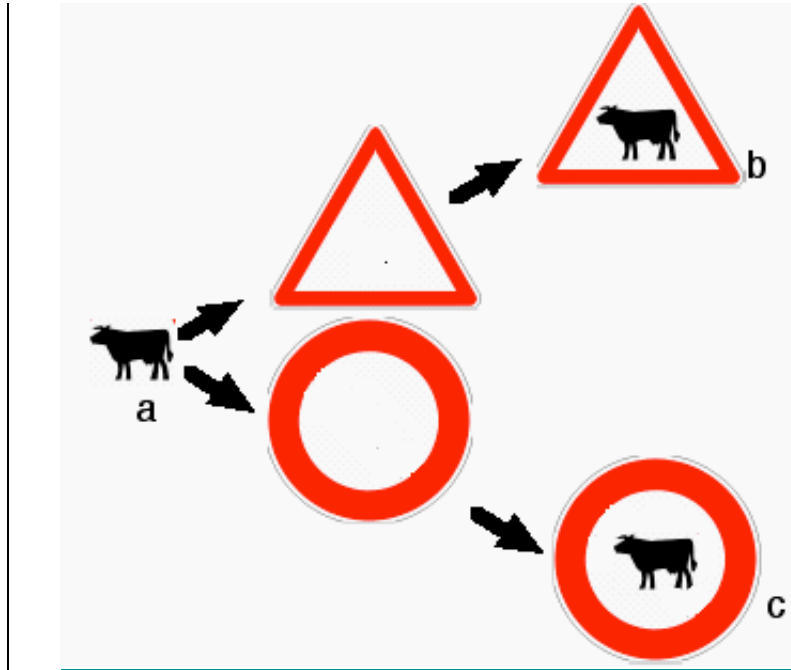
Figure 1: The making of a road sign.

Figure 1 presents the realization of a road sign: the "cow icon" (which stands for any cattle) combined with (b) a red bordered triangle means that there is a danger *because* of the eventual presence of cattle on the road, or with (c) a red bordered circle, would mean that this way is forbidden *to* domestic animals. Note that (b) could be "Danger for cows" and (c) could be "forbidden because of cows".

Do the users know about this combinatory? Are they capable of deducting the meaning of an unknown sign, using the combinatory rules supposed to be known? We think that it is the context in which appear road signs which determines our decision about the meaning of road signs.

Rules and driving

Data [9] show that a good expertise level is associated with a bad knowledge of the (theoretical) Highway Code. The knowledge of the meaning of road signs decreases with the number of years of practice but the knowledge of the correct action to perform improves. For instance, we found that correct interpretation of road signs seen in isolation was of .42 for people driving cars more than 10 years vs. .9 for people driving cars less than 2 years. Thus, more people drive, the more the gap between procedures and practices increases. In other words, the way in which a practice diverges from the official procedure is an indicator of the expertise level. We reasoned that this is so because an expert will take into account more of the driving

situation than prescribed by the Highway code rules : the whole situation, including contextual knowledge.

If there is a knowledge transformation along with the practice of driving, from a theoretical knowledge to an operational knowledge, then practice as the contextualization of Highway Code rules, i.e. rules put into context, rules and context being judged globally as a whole. Then, with the acquisition of expertise, road signs lose their rule codification function to become one of the elements that entail the process of contextualizing a driving situation.

Practices formalization

The fundamental role of contextualization when driving is to unify driver's goal and decision making with the environment. This can be shown in the following example (figure 2).


Figure 2: The road sign "dangerous bend on right" in 3 different contexts.

Even if the "Danger because of a left turn" is the same in the three images of Figure 2, these 3 different situational contexts will not produce the same decision-making and subsequent behaviors from road users: the first case incites effectively to reduce speed immediately (the road sign is almost in the bend), the second has a more doubtful effect: (1) It could distract the user from the concrete situation (where it's the other cars being stopped that requires to reduce speed) and (2) Is the bend dangerous only in case of slippery road? In the last picture, the utility of the road sign (fixed whereas variable messages road signs exist) on a road that must be often blocked by traffic, then where speed isn't very high, is debatable (and probably intervene as a distractor).

Therefore, it is necessary to take explicitly the context of practices into account, if we want to explain and formalize them.

Contextual graphs [10,11] allow producing a representation of practices based on context. They are oriented graphs, acyclic and with a general structure in spindles. A contextual graph is made of nodes and arcs and, more particularly, actions (noted A), contextual nodes (NC), recombination nodes (RC) and groups of parallel actions.

We show the theoretical contextual graph that could be built from the road sign "*Dangerous bend on right*":
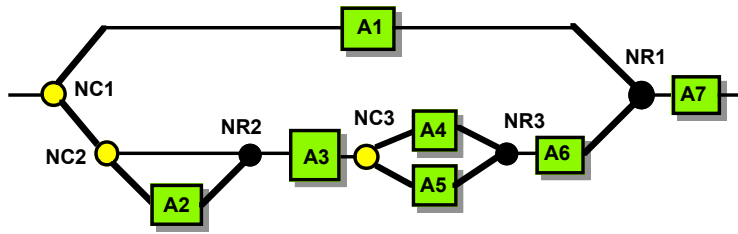
NC1	Do I see the road sign?
NC2	Yes. Do I recognize it?
NC3	What about the distance to obstacle?
NR1	I have to…
NR2	I do recognize the road sign.
A1	No, then I keep the same behavior.
A2	No, then I have to identify it from the situation.
A3	I have to find the situation corresponding to the road sign.
A4	Obstacle is close, then I focus on it immediately.
A5	Obstacle is far, I postpone first other actions.
A6	I reduce my speed in order to …
A7	… Turn right.

Figure 3: Contextual graphs associated to the road sign "*Dangerous bend on right*" presenting the set of possible actions.

Contextual Graphs make it possible to describe practices (figure 3) as well as the strict application of the prescribed procedure of the Highway Code (the black way in the Contextual Graph displayed in figure 4).
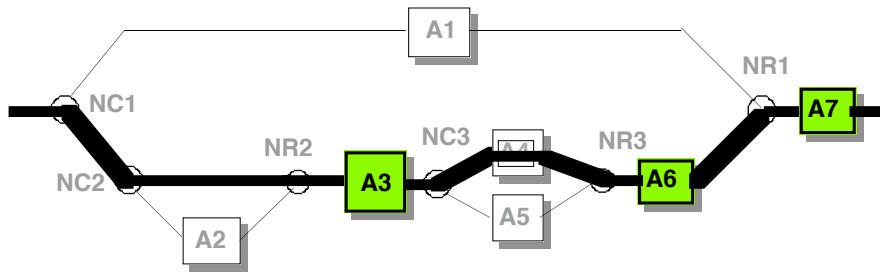

Figure 4: Description of the prescribed procedure derived from the Highway Code for the road sign "*Dangerous bend on right*"

Thus, prescribed procedures derived from the Highway Code do not capture the complexity of the driving activity and deny the diversity of possible behaviors when facing road signs. We state that it is thanks to a study of practices in context that we can touch the nature of the spread between procedures and practices, and then, some law transgressions.

Conclusion

We have pointed out that there is a gap between driving rules prescribed by the law and users practices. This is a gap that increases with years of experience as shown by data. We reasoned that the main difference between young and expert drivers lies in an appropriation of road signs by expert drivers as contextualization of road signs that allows to identify, not only the road sign itself (as young driver), but the occurring situation as other situations already encountered in a "situation based reasoning process" approach.

The uncertain interpretation of a road signs message allows us to take the context into account, giving information regarding to the circulation context (traffic jam in 5 km) and to the individual contexts of users (traffic jam in 5 km, reduce your speed from 120 to 80 km/h).

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