Risk profiles estimated by SafetyNex : Analysis of profiles, and possible use to detect fatigue and hypovigilance of driver

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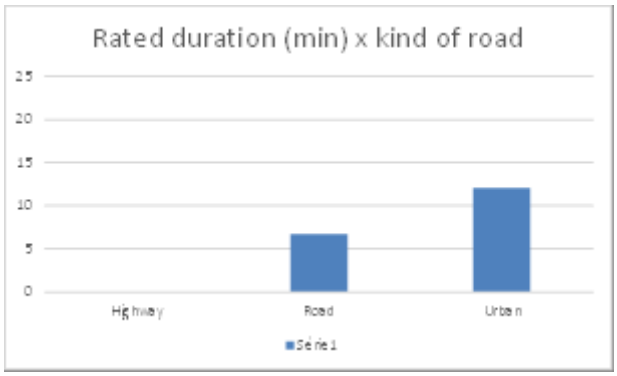
1 – REMINDER ON THE FUNCTIONING OF SAFETYNEX

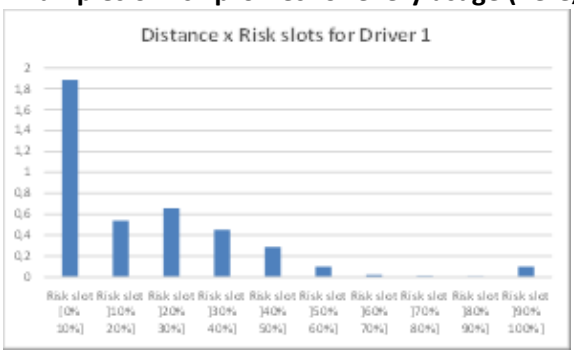
SafetyNex is a nomadic real-time risk estimation system. The system has been described in detail in previous publications [1] and uses the key concept of "near-accident" or "quasi-accident", and is a result of 15 years of collaborative research with road safety experts and researchers.
The main competitive advantage of **SafetyNex** is that it allows, since the risk is estimated in real time, to warn the driver (vocal alert), and thus to allow driver to avoid accident. Studies show that **SafetyNex** can reduce accident rate by 20% [2], which represents for insurers and fleet managers a consequent increase in margin [3].
But of course, **SafetyNex** also records usage and risk profiles. These profiles provide the behavior of the driver, or more precisely, his/her ability to regulate driving task consistently with danger. No need to record large volumes of data (accelerations, etc...) which in reality are not data (these are signals) for a possible back-office analysis, **SafetyNex** provides exactly the interesting data [4].
Below are examples of usage profiles and driver risk profiles.

2 –EXAMPLES OF DATA COLLECTED BY SAFETYNEX

. Examples of usage data :
Total duration
Total distance
Start time
End time
Kind of infrastructure :

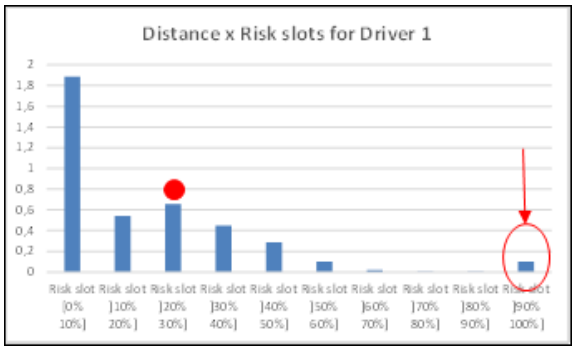


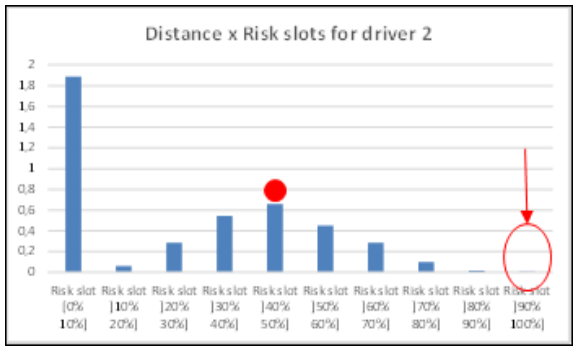
. Examples of risk profiles for every usage (here, urban traffic):



3 –VISUAL ANALYSIS OF THOSE DATA

. Comparison of two risk profiles in urban traffic :

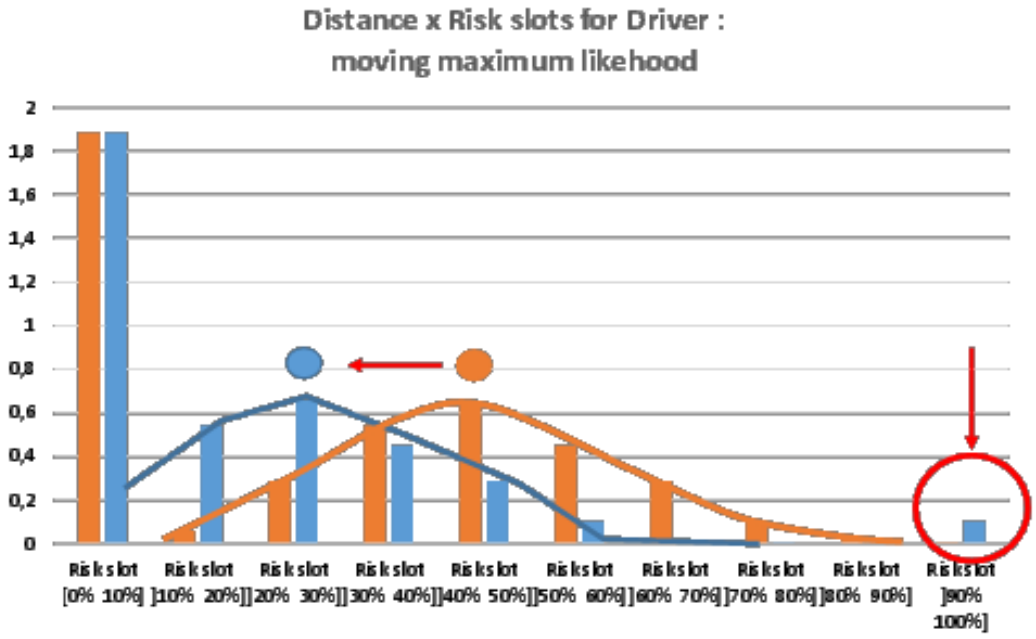




4 – MENTAL LOAD CONCEPT AND MEASUREMENT OF THE RISK PROFILE: DETECTION OF FATIGUE AND HYPOVIGILANCE

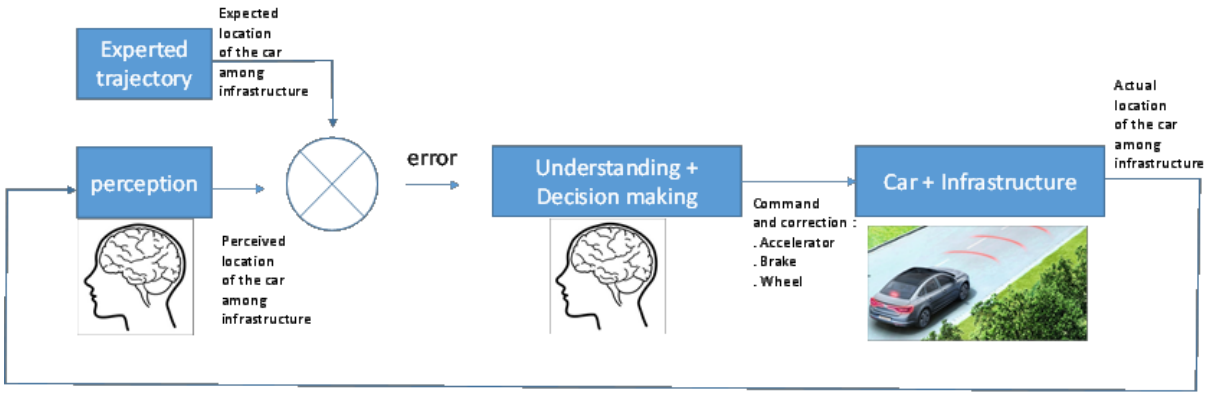
Psychologists and human factor researchers model the task of driving with the concept of "mental load". The mental capacity of driver can be seen as an « empty glass ». Each task fills this glass partially with a quantity called mental load [5].
When the number of tasks to be performed increases, the overall mental load exceeds the capacity of the glass. This type of model is used to study the relevance of new driver assistance systems that involve new tasks of interaction between the vehicle and the driver.

. Assumptions :
We wish to formulate a corpus of assumptions, and encourage researchers in human factor to study them in order to confirm, or not the following sentences:
. The risk profile is an image of the control task of driving: the driver must adapt his/her commands to follow the shape of infrastructure and regulate the risk. The risk profile is therefore an image of the driving style in the sense that it is the fingerprint of the mode of regulation used by the driver to adapt driving style to infrastructure.
. The maximum likelihood of the risk profile is an estimator of the risk taken voluntarily (or consciously by the driver).
We assume that for a given driver, the mental load required for driving increases with this maximum likelihood. As a result, novice drivers who naturally use a big mental load to drive (as they have not yet acquired all automations) will tend to "slow down" and thus position their maximum likelihood at low risk. We also hypothesize that the experienced driver, with efficient automation that unloads his work experienced driver can roll a little faster without being overwhelmed by the amount of information to be processed, which is characterized with a maximum of likelihood of the higher risk profile.
This would mean that the driver would regulate his voluntary risk so that his mental load would be "sufficiently high" so as not to "forget that he/she is driving", and "sufficiently low" not to be overwhelmed or tired by the task of driving.
If this is true, then, during the driving task, a shift to the left of the maximum likelihood should be seen as fatigue increases. And if the infrastructure has difficulties, then high risk alerts should also happen.
On the contrary, we believe that temporary hypovigilance (typing a SMS, searching for something in the car, ...) should lead to high risk alerts without really changing the overall shape of the risk profile.



If those assumptions are at least partially validated, this means that **SafetyNex**, in addition to being used as a real time driving risk assessment system, could also be used to detect driving fatigue and hypovigilance.

. Theoretical foundations of our assumptions :
The driving task is a control / command task:



Fatigue potentially generates two effects:
. A poor perception of the situation (imprecise, erroneous)
. Less precise control and slower correction

Consequently, the only solution which seems to us possible within the framework of this scheme for a tired driver is to slow down in order to maintain a margin of control and compensate by this control the inaccuracies of perception and elaboration of the command. By slowing down, the driver makes the maximum likelihood of risk profile shifting to the left. The driver slows down only for a reason of comfort: the room of mental capacity available for the driving task decreases and the driver decreases his mental load by slowing down so as to restore his/her "comfort". If he/she does not slow down (if he/she is not aware of overflow of mental capacity) then each difficulty of the infrastructure leads to a high risk alert.

In cases where the dangers of the infrastructure appear suddenly, the tired driver finds it harder to anticipate them (so he has not already applied an adapted command) and his/her elongated reaction time triggers high risk alerts.
In other words, as long as he/she is aware of the danger, an experienced driver turns into a beginner with fatigue.
Except of course if he/she is no longer interacting with the infrastructure (case of the deserted highway in a straight line: the driver is not solicited).

. Work still to be done :
We count on the human factor research community to contact us and work with us on work to validate our assumptions.

5 – REFERENCES

[1] SafetyNex, a new way to measure driving risk :
http://nexyad.net/Automotive-Transportation/wp-content/uploads/2016/06/THE-ULTIMATE-SOLUTION-FOR-INSURANCE-COMPANIES-THAT-NEED-ONBOARD-RISK-ASSESMENT1.pdf

[2} SafetyNex can reduce accident rate by 20% :
http://nexyad.net/Automotive-Transportation/wp-content/uploads/2016/06/Smartphone-App-SafetyNex-reduce-accident.pdf
[3] SafetyNex lets car insurer and fleet manager increase their margin :
http://nexyad.net/Automotive-Transportation/wp-content/uploads/2016/11/Paper-5-En.pdf
[4] Extract of SafetyNex User Guide, « Data » :
http://nexyad.net/Automotive-Transportation/wp-content/uploads/2017/01/DATA-SafetyNex-Manual_Eng_ALPHA-TEST_v2_208.pdf
[5] Mental Workload of the driver :
https://www.researchgate.net/publication/220043547_A_method_to_assess_the_driver_mental_workload_the_Driving_Activity_Load_Index_DALI