Title: Calibration of Drivers Perceived Level of Risk in an Uninterrupted Traffic Facility: An Experimental Study

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Keywords: Risk Homeostasis, Accepted Risk Level, Experimental Study

According to Wilde’s risk homeostasis theory (RHT), the system user tends to compare the perceived risk with the target (accepted) level of risk and decides to adjust behavior as a response in a way that minimizes discrepancy between the two risk levels. Despite criticism of the theory, and while the RHT is basically a theory in psychology, if well bridged into engineering knowledge, it may also have potentials in smart design in engineering domains. In engineering the final product should necessarily act out in the way that the user (system operator) is nudged to behave in the same way as expected by the designer, with minimal behavioral adjusting efforts (side effects) and erroneous actions.

Although perceived and accepted risk levels are key constructs in RHT, efforts to effectively measure the two terms in engineering applications are still considered inadequate. As an attempt to mitigate this gap, the present study aims to quantitatively detect occasions when the perceived level of risk equals the accepted risk level on an aggregate basis. To do so, a novel infrastructure to vehicle intelligent system was devised and implemented in an instrumented segment of uninterrupted traffic facility equipped with a variable message sign, with the aim to communicate with drivers, the near real time risk of rear-end collision. The real time micro-level traffic data obtained by inductive loop sensors were analyzed and the level of rear-end collision risk as a dichotomous variable was estimated, displayed and refreshed at 5-min intervals in the form of low/high risk levels. The appropriate levels were obtained based upon the predetermined proximal safety indicator and the crisp thresholds.

According to RHT, people get entertained by the risk level they are shown, in the form of amending behavior, once the risk level corresponds with perceived risk, and at the same time the two levels are equal to the accepted risk. In a reverse presumption, the occasions under which the significant amending effects in behavior are observed are those well-fitted to situations in which the transmitted risk level (by message), the real time perceived risk level and the real time accepted risk level have the same values. Such occasions can be translated into quantitative engineering measures, for further applications.

The system was in use for two days to send near real time risk of rear end collision to drivers, after it was operationalized under the continuous messages with no direct effects on car-following for two days. Safety Margin (SM) as a car following safety performance indicator was used to quantify behavioral changes under the message of "high risk". Mean values of SM under this message were compared with the mean values of SM under the null message. The strongest behavioral effect (in terms of increasing in SM values) under the message was observed in car-following cases where the time headway was less than three seconds. The effect was highly significant for slow moving lanes in night hours and significant in day hours, a slight effect was observed at the fast moving lane during night hours, but no effect at day hours. Furthermore the effect was not significant at the middle lane both during day and night hours.

In addition, driving speed as a safety performance indicator was used to quantify behavioral shifts under the message of low risk. Mean values of speed under this message were compared with the mean values of speed under the null message. The behavioral effects under the message (in terms of increasing in speed) were revealed in cases where the time headway was more than three seconds. The effect was highly significant for all lanes during
night hours and non-significant during day hours. Such situations correspond with situations when the drivers perceived the risk the same as what they are displayed.