**International Conference on Safety and Mobility of Vulnerable Road Users: Pedestrians, Motorcyclists, and Bicyclists**

**Jerusalem, Israel, May 30-June 2, 2010**

**Title:** INVESTIGATING RISK COMPENSATION THEORY IN CYCLISTS: RESULTS FROM INTELLIGENT VIDEO ANALYSIS SYSTEM

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Abstract:
Background: Head and brain injuries account for most fatalities and disabilities among cyclists. Encouraging helmet use might be of interest to improve safety, but it is challenged by some researchers stating that it might have negative consequences. Risk compensation theory postulates that the likelihood of being involved in a crash is higher among helmeted cyclists as compared with others, because they feel safer and consequently take more risk. In the absence of robust data on cyclist's behaviours, sound evidence of risk compensation is missing. The aim of the present study is to assess risk behaviours in urban cyclists by helmet-use status, using an innovative on-site observation technology.

Method: An Intelligent Video Analysis System (IVAS) was positioned in a one-way street of Bordeaux (France) with heavy motorized and cycling traffic, but no cycle lane. Cyclists were observed through an Internet Protocol (IP) camera placed in height and implemented with specific Image Analysis Softwares. This IP camera is programmed to detect moving objects, in particular cyclists. It computes quantitative behavioural measures such as speed, and is able to detect the use of sidewalk. A second synchronized camera takes pictures of each detected cyclist; pictures are used to collect other data such as cyclist's gender, helmet use, and red light infringement. Information collected by cameras is sent to a central server located in our settings and coded in a database by a trained video coder. Sport and child cyclists were not included in the current study. The study protocol was approved by the French national review board.

Results: During a 4-month observation period, 10 126 cyclist sequences were video-captured and analyzed (Males= 53%). Helmet use was observed in 6% of cases (8% among men and 4% among women). One sequence out of five was detected on the sidewalk. The use of sidewalks was more frequent in helmet non-users (21%) as compared to users (12%, p<0.001). Among those riding on the road (N=8109), mean average speed was estimated at 18 kilometers per hour (SD: 5). Among men, helmet users ran faster than non users (20 vs. 17 km/h, p<0.001). Among women, by contrast, there was no speed difference by helmet use (16.1 vs. 16.2 km/h, p>0.05). Men ran faster than women (19 vs. 16 km/h, p<0.001). When traffic light was red (N=3814), infringements were observed in 60% of cases. Red light infringements were more frequent among men (65%) than women (54%, p<0.001), with no difference by helmet use.

Discussion: These findings suggest that risk behaviours are frequent among urban cyclists, while helmet use is rare. They are compatible with the hypothesis of risk compensation among men, but not among women. Non-helmeted cyclists are more likely to avoid motorized traffic by using the sidewalks, but this behaviour can lead to risky situations with others vulnerable road users, especially pedestrians. Further studies are required to elicit and prevent possible negative consequences of mandatory helmet use; for example, the possibility and direction of a causal relationship between speed and helmet use among men remains to be determined. By collecting vast amounts of reliable information on cyclists during their daily trips, IVAS might prove to be a valuable tool to improve prevention toward vulnerable road users.