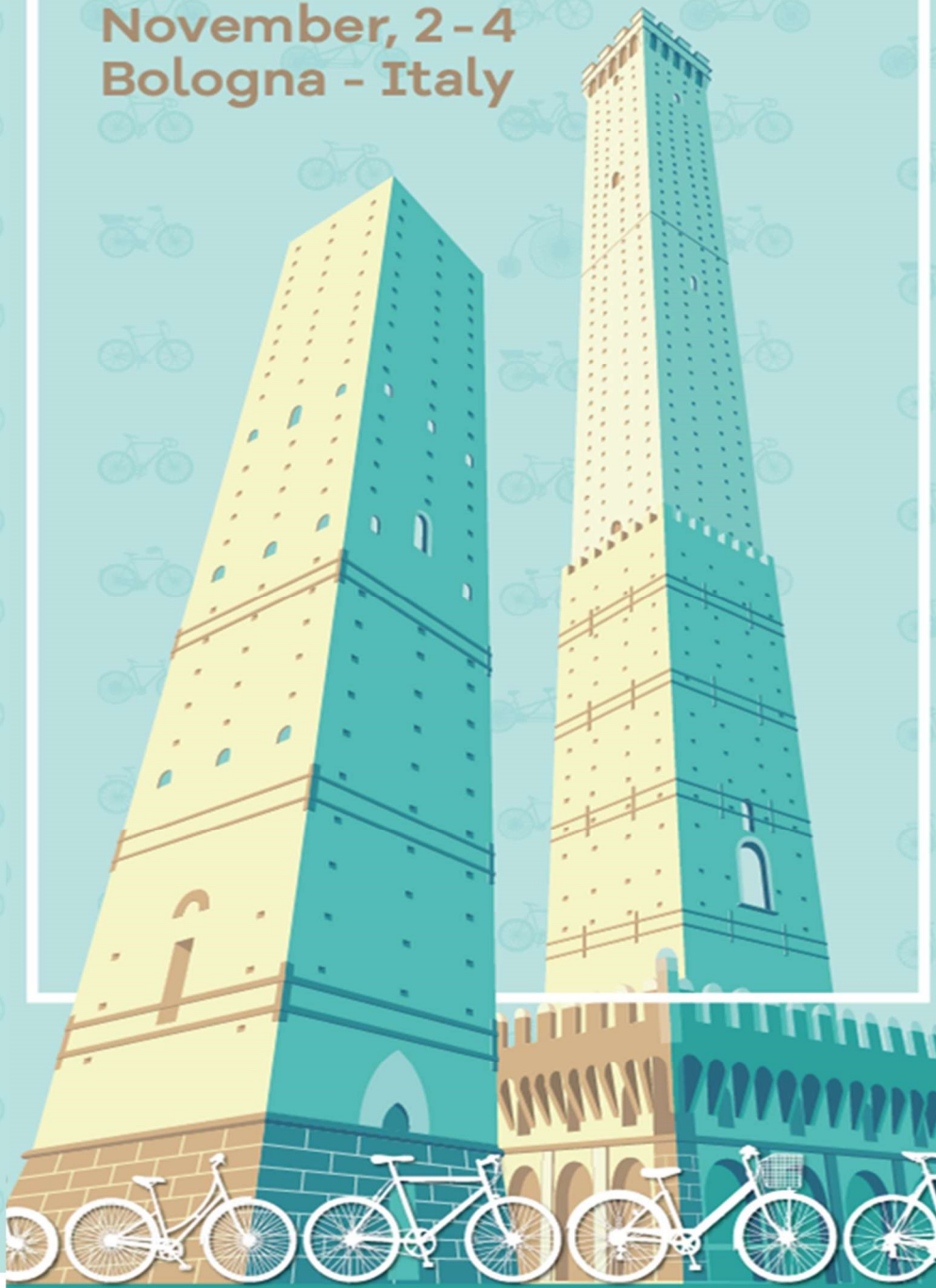


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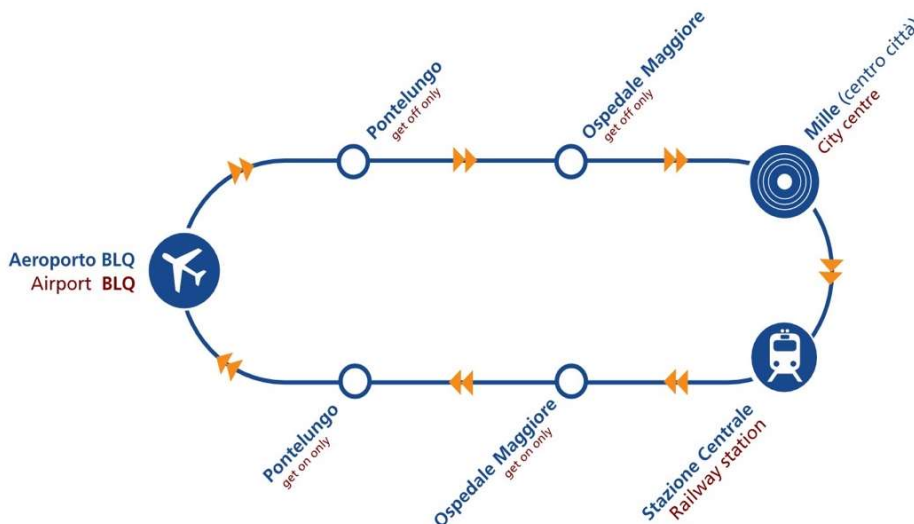
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## DAY 1

### S1: INFRASTRUCTURE AND CYCLISTS BEHAVIOUR

#### ***Red-light running behaviors of cyclists in Italy: an Observational Study***

Author(s): Federico Fraboni, Filippo Fassina, Marco De Angelis, Víctor Marín Puchades, Pietro Marengo, Luca Pietrantoni, and Gabriele Prati

Presenter: Federico Fraboni (federico.fraboni3@unibo.it)

Department of Psychology, Alma Mater Studiorum University of Bologna, Bologna, Italy

#### ABSTRACT

Accident analysis and studies on traffic revealed that cyclists' violation of red-light regulation is one typical infringement committed by cyclists. Furthermore, an association between cyclists' crash involvement and red-light violations has been found across different countries. The literature on red light running cyclists' behaviors in relation to their characteristic is still scarce. The present study, basing on the classification of cyclists red-light behavior in risk-taking, opportunistic and law-obeying, adopted an eye-observational methodology to investigate differences in cyclists' crossing behavior at intersections, with a particular attention to their characteristics. Two researchers at a time registered unobtrusively at four different intersections, during morning and late afternoon peak hour traffic, 1381 cyclists approaching the traffic light during the red phase. The 62.9% of observed cyclists violated the traffic control. Results showed that the visual search strategy displayed by the cyclists and the presence of other cyclists at the intersection are important factors in predicting the probability of red-light running behavior.

**keywords:** Cycling behaviors, Red light violations, Cyclists characteristic, Road Safety

#### ***Traffic safety on cycle track crossings – traffic conflict technique***

Author(s): Paweł Włodarek, P. Olszewski

Presenter: Paweł Włodarek (p.wlodarek@il.pw.edu.pl)

Warsaw University of Technology, Warsaw, Poland

#### ABSTRACT

In Poland, the bicycle traffic is on the rise. Over the last 10 years the share of bicycle travels in Warsaw increased from 0.9% to 3.1%. This development is accompanied by an increase in incidents in which cyclists are involved. Between 2010 and 2014 there were approx. twice as many accidents and almost three times more collisions, 25% of which took place at cycle track crossings. A set of studies conducted within a dissertation project was to analyse safety of bicycle users on various crossings types. Incidents involving cyclists are very scattered, thus epidemiological analyses do not give satisfactory results. In the reported study the traffic conflict technique was used. Measurements were carried out for three cycle track crossings, differing with respect to geometrical solutions and traffic control methods. Video recording technique was applied – approx. 70 hours of material were analysed in each measurement point. Dangerous situations were identified (approx. 700) and categorized (into 6 types of incidents). Subsequently we have analyzed the relationship between conflict situations and traffic volume. This allowed to identify traffic solutions that are safer and to list design elements that should be avoided.

**keywords:** Cyclist safety, surrogate safety measures, traffic conflicts technique, vulnerable road user safety



### ***Apartheid or anarchy –roundabouts as a case of different segregation strategies, and their effects on perceived and real safety in Norway, Sweden and Denmark***

Author(s): Aslak Fyhri, Aliaksei Lareshyn, Torkel Bjørnskau

Presenter: Aslak Fyhri (af@toi.no)

*Department of Safety, Security and Environment - Research Area Environment and Climate, Institute of Transport Economics, Norwegian Centre for Transport Research, Oslo, Norway*

#### **ABSTRACT**

Cyclists tend to express a preference for separated infrastructure rather than sharing the road with cars. However, segregation as a principle is known to be associated with a higher risk of accidents whenever road user groups are forced to meet, at intersections. Norway, Denmark and Sweden have adopted different principles for planning of cyclist infrastructure, with var-ying degrees of traffic separation. In the current study, video observations and survey data are used to compare cyclists' and car drivers' interaction and experiences at roundabouts in Norway (no segregation), Denmark (in-termediate segregation) and Sweden (high segregation). Safety is measured using a surrogate measure, the Swedish traffic conflict methodology. The results confirm that cyclists tend to prefer solutions with high degrees of separation. How-ever, the conflict levels do not correspond to perceived safety. The Danish solutions (a marked cycle path in the roundabouts) give more conflicts than the typical Norwegian solution mixing traffic.

**keywords:** Roundabouts, video-analysis, traffic segregation, psychology

### ***Yielding behavior at cyclist crossing facilities on channelized right-turn lanes***

Author(s): Wouter van Haperen, Stijn Daniels, Tim De Ceunynck, Nicolas Saunier, Tom Brijs, and Geert Wets

Presenter: Wouter van Haperen (wouter.vanhaperen@uhasselt.be)

*Hasselt University, Transportation Research Institute (IMOB), Diepenbeek, Belgium*

#### **ABSTRACT**

Channelized right-turn lanes are a means of improving traffic flow efficiency, enabling right-turning drivers to bypass the traffic lights at signalized intersections (for right-hand drive countries). In many cases, crossing facilities for pedestrians and cyclists are constructed on these right-turn lanes. Previous studies examining the safety performance of channelized right-turn lanes indicated that overall safety levels increase, but hint that certain issues with regard to vulnerable road users exist. This study investigated these safety issues by observations of yielding behavior and the effect of the priority ruling on cyclists' safety at two channelized right-turn lane designs. Four locations were selected: two where the priority ruling favored the cyclists and two where motorists were in priority. The four locations were videotaped unobtrusively during one week. With regard to yielding, four types of crossing behavior were identified and defined. The video data show that, independent of the priority ruling, cyclists cross first in most of the interactions using a defensive crossing style. A model was developed indicating that being a pedal cyclist instead of a moped rider and arriving from the left at the cyclist crossing facility increases the probability of the vulnerable road user to cross first. Slowing down behavior of either road user decreases his/her probability to cross first. A safety evaluation was executed, using two conflict indicators (TTCmin and the TA-value). High correlations between the two indicators were found ( $r^2 > 0.83$ ), but no conclusions about the safest form of priority ruling for cyclists could be drawn. The results hinted however that motorist priority and crossing from right to left (from the drivers point of view) yielded the most safety critical events.

**keywords:** Behavioral observation, Cyclist crossings, Yielding behavior

***Tram tracks and slippery slopes – combining hospital and survey data to map risk factors for on- and off-road bicycling***

Author(s): Hanne Beate Sundfør, Torkel Bjørnskau

Presenter: Hanne Beate Sundfør (hbs@toi.no)

*Department of Safety, Security and Environment, Institute of Transport Economics (TØI), Oslo, Norway.*

**ABSTRACT**

It is well known that bicycle accidents with personal injury are poorly registered in official records. In particular, single accidents are underreported. Hence, there is a knowledge gap concerning factors that contribute to single bicycle accidents. In order to calculate risk, travel behavior data are often used to account for exposure. However, off-road cycling is seldom registered in such surveys. Thus risk assessments are done only on part of the exposure. The aim of the study is to investigate how infrastructure factors contribute to accidents, both in traffic and off-road. A secondary aim is to investigate risk differences between on- and off-road cycling. The Emergency unit in Oslo, Norway, registered all bicycle accidents in 2014 (N=1972). We use these data, and a survey among a sample of bicyclists in Oslo (N=2462), to explore the characteristics and severity of bicycle accidents. Exposure measures are collected through a travel diary. Initial results show that 80% of the accidents happened when cycling in traffic and 20% when cycling off-road. Slip and tip over was the most common reason for all accidents. Off-road, riding into an obstacle accounted for 18% of the accidents. In many cities tram tracks can be found in close proximity to cycling infrastructure. Our results show that tram tracks are accountable for 7.5 – 8.4% of the accidents in traffic. In order to estimate the risks associated with tram tracks and off road cycling, risk levels will be calculated and presented at the conference.

**keywords:** bicycle accident, risk levels, on- and off-road

## S2: NATURALISTIC STUDY AND ACCIDENT ANALYSIS

### ***Principles and Study Design of the First Austrian Naturalistic Cycling Study BIKEALYZE***

Author(s): Sven Leitinger, Martin Loidl, Elisabeth Füssl, Florian Lorenz, Ulrike Brocza

Presenter: Elisabeth Füssl (elisabeth.fuessl@factum.at)

*FACTUM Chaloupka and Risser OG, Wien, Austria*

#### **ABSTRACT**

Naturalistic Cycling studies have gained considerable attention as scientific method to study the interaction of cyclists with their surrounding environment. To this date no naturalistic cycling study have been conducted in Austria. Generally, there is little evidence on the trade-off between the efforts and the gained knowledge, depending on various data acquisition methods. Therefore the project BIKEALYZE evaluates the methods (1) mobile eye tracking, (2) collection of GPS-based motion data together with acceleration and steering direction data and (3) video observation. In this study naturalistic cycling data from 24 test persons participating in two ex-periments in Salzburg and Vienna are collected. High priority is given to maintaining naturalistic cycling conditions, e.g. no restriction or distraction through equipment. The motion and video data are acquired with off-the shelf hardware (action cams and smartphones). Collected data are analysed automatically (sensor data) and manually (mobile eye tracking and video data) with respect to safety-critical events (e.g. collision avoidance, way-giving violations). The data are then (semi)-automatically referenced to the authoritative digital street network Graph Integration Platform (GIP) of Austria, which includes information about cycling infrastructure. The study's results will contribute to the definition of quality standards for naturalistic cycling studies with regard to data collection, analysis and interpretation.

**keywords:** naturalistic cycling study, infrastructure, mobile eye-tracking

### ***What is the relation between crashes from crash databases and near-crashes from naturalistic data?***

Author(s): Marco Dozza

Presenter: Marco Dozza (marco.dozza@chalmers.se)

*Department of Applied Mechanics, Chalmers University of Technology, Göteborg, Sweden*

#### **ABSTRACT**

Naturalistic cycling data are increasingly available worldwide and promise ground-breaking insights into road-user behaviour and crash-causation mechanisms. Because few, low-severity crashes are available, safety analyses of naturalistic data often rely on near-crashes. Nevertheless, the relation between near-crashes and crashes is still unknown, and the debate on whether it is legitimate to use near-crashes as a proxy for crashes is still open. This paper exemplifies a methodology that combines crashes from a crash database and near-crashes from naturalistic studies to explore their potential relation. Using exposure to attribute a risk level to individual crashes and near-crashes depending on their temporal and spatial distribution, this methodology proposes an alternative to blackspots for crash analysis and compares crash risk with near-crash risk.

**keywords:** Traffic safety, near-crash analysis, crash risk, exposure, blackspots



### **Reporting bicycle accidents to police in the COST TU1101 survey data base: Cross-country comparisons and associated factors**

Author(s): Shinar, D.; Houtenbos, M.; Haworth, N.; Schramm, A.; Valero-Mora, P.; Mascarell, O.; Fyhri, A.; Hursa, A.; De Bruyne, G.; Morandi, A.; Dietmar, O.; Papadakaki, M.; Tzamalouca, G.; Cavallo, V.; Kuklane, K.; Dias, J.; Crundall, D.; Ledesma, R.; Muser, M.

Presenter: David Shinar\*, Valero-Mora, P. (Pedro.Valero-Mora@uv.es)

\*Department of Industrial Engineering and Management, Gurion, University of Negev, Be'er Sheva, Israel

General Studies University of Valencia, Valencia, Spain

#### **ABSTRACT**

Police crash reports are often the main source for official data in many countries. However, police sampling and data are known to be subject to bias, making the countermeasures adopted according to them possibly inefficient. In the case of bicycle crashes, this bias is most acute and it probably varies across countries, with some of them being more prone to reporting accidents to police than others. Assessing if this bias occurs and the size of it can be of great importance for evaluating the risks associated with bicycling. The following paper utilizes data collected in the COST TU1101 action. The data came from an online survey that included questions related with bicyclists' attitudes, accidents, and pattern of use of helmets. An average of only 10% of all crashes were reported to the police (minimum of 0.0% Israel and 3.37% Greece to a maximum of a 30% of Germany). Some factors associated with the reporting level were: type of crash, type of vehicle and injury severity. Finally, no relation was found between the likelihood of reporting and the cyclist's gender, age, use of helmet, and type of bicycle. The significant under-reporting justifies the use of survey data for assessment of bicycling crash patterns as they relate to crash risk issues such as location, cyclists' characteristics, and use of helmet and strategic approaches to bicycle crash prevention and injury reduction, which are discussed in the paper.

**keywords:** crash, reporting, patterns

### **The rise in single bicycle fatalities in Australia and Netherlands**

Author(s): Soufiane Boufous, Jake Olivier, Paul Schepers.

Presenter: Soufiane Boufous (soufiane@unsw.edu.au)

Transport and Road Safety, University of New South Wales, Sydney, Australia

#### **ABSTRACT**

Background Recent media reports continue to highlight the risk fatality as a result of cyclist crashes, particularly those involving motor vehicles. Aims To examine recent trends in cyclist fatalities in Australia and Netherlands with a focus on single vs multiple vehicle crashes. Information on cycling fatalities was extracted from data on all national road fatalities as reported by the police in Australia between 1991 and 2013. Same information was obtained from causes of death statistics in the Netherlands between 1996 and 2013. Poisson regression was used to examine trends in both countries. In Australia, cyclist deaths following multivehicle crashes decreased at a rate of 2.9% per year and those resulting from single vehicle crashes increased by 5.8% per year between 1991 and 2013. Similarly, in Netherlands, multivehicle fatalities decreased by 3.8% per year and single bicycle fatalities increasing by 7.1% per year. The Dutch data also show that the risk ratio, in terms of single cyclist fatalities per bicycle kilometre, between 2011-2013 and 1996-1998 was higher among those older than 50 years (3.3) compared to those aged.

**keywords:** trends, single bicycle, fatality

**Comparison of rides on an electric and a conventional bicycle in a naturalistic cycling study**

Author(s): Jan-Philipp Sander, Stefanie Marker

Presenter: Jan-Philipp Sander (sander@mail.tu-berlin.de)

*Chair of Naturalistic Driving Observations for Energetic Optimisation and Accident Avoidance, Technische Universität Berlin***ABSTRACT**

Pedelecs are e-bikes which only assist the rider while pedaling. During the last years, their number has increased continuously. In 2015, their market share in bicycles was 12.5 % in Germany [1]. Whether this causes risks in mixed traffic with conventional bicycles or if existing cycling infrastructure is appropriate for the use with pedelecs, is part of current research. To determine differences in the use of pedelecs and conventional bicycles in traffic, field tests were conducted in Berlin. A pedelec and a conventional bicycle with similar geometry and features were equipped with identical measuring systems, consisting of four cameras, two microphones and a GPS unit. Seven subjects rode each of the vehicles for a week, mostly for trips to and from the workplace in an urban area. Over 900 km worth of data were recorded. The average speed for all riders was 19.5 km/h on the pedelec and 17.5 km/h on the conventional bicycle. An even bigger difference is found in the comfort speeds, the speed chosen by the rider on unobstructed infrastructure: On the pedelec, it was about 25.9 km/h, which corresponds to the built-in limitation for motor assistance. This is implemented for the pedelec to be qualified as a bicycle according to German law. On the conventional bicycle, the comfort speed was significantly lower, with 21.8 km/h. In Berlin, use of most bicycle paths is not obligatory. Riders may decide to cycle on the road instead. However, no significant differences in infrastructure choice were observed between rides on the pedelec and conventional bicycle.

**keywords:** naturalistic cycling, fot, pedelec, e-bike**Seasonal variation in bicycle collisions as a function of number of cyclists – an exploration of the Safety in Numbers mechanism**

Author(s): Aslak Fyhri

Presenter: Aslak Fyhri (af@toi.no)

*Department of Safety, Security and Environment - Research Area Environment and Climate, Transportøkonomisk institutt, Oslo, Norway***ABSTRACT**

The concept of Safety in numbers is used to explain the non-linear statistical relationships between the number of pedestrians (or bicyclists) and the number of injuries for the same group (Elvik, 2009). In previous studies the natural seasonal variation in cycling frequency in Oslo, Norway has been exploited (Fyhri et al. 2016). These studies have indicated a short term Safety in Numbers effect through the season. Cyclists experienced fewer occasions of being overlooked by cars and fewer near misses. Video observation data confirmed this. In the current study accident data were collected from a prospective population-based study, during 2014 at the Oslo Emergency Clinic. These data are matched with monthly cycle flow data. Both collisions and single accidents are closely related to the number of cyclists on the road. However, when we look at the relative difference between single accidents and collisions (the ratio), we see that collisions decrease relative to single accidents when cyclist numbers increase. In December, 28 % of all cyclist accidents are collisions, a figure that drops to 10 % in July. The seasonal Safety in Numbers effect that previously has been shown in relation to near misses and conflicts, can also be seen in accident data. The results are discussed in light of potentially confounding factors such as lightning conditions and road conditions.

**keywords:** Safety in Numbers, Accidents, Hospital data

### S3: INNOVATIVE BICYCLE SAFETY SOLUTIONS

#### ***A review of current online bicycle routing portals and their potential role in promoting safer bicycling***

Author(s): Martin Loidl, Robin Wendel, Bernhard Zigel

Presenter: Martin Loidl (artin.loidl@sbg.ac.at)

Department of Geoinformatics, Universitat Salzburg, Salzburg, Austria

#### **ABSTRACT**

The role of user-tailored information as integral part of comprehensive bicycle promotion strategies is widely acknowledged in literature and practice. Bicycle routing applications on the web, often integrated into information portals, provide a wide variety of content and functionality. However, bicycle safety is hardly ever addressed explicitly, although safety concerns are among the most relevant factors that keep people from utilitarian bicycling. We did a systematic review of 30 bicycle routing applications, which are freely available on the internet, do not necessarily require registration and provide a desktop version. We thereby hypothesize that current bicycle routing applications do not fully exploit their potential in anticipating safety concerns and provide information about safe routes. In order to illuminate further research and development paths we contrast findings from literature with currently available portals and derive recommendations for the content, functionality and design of bicycle routing portals, which contribute to the promotion of safer bicycling.

**keywords:** Information service, safety, routing, review

#### ***Innovative Technology applied to a Cycling Helmet to Increase Protection Performance against Head Injuries.***

Author(s): Thomas B. Hoshizaki, Andrew Post, Elizabeth F. T. Legace, Carlos Zerpa, T. Blaine Hoshizaki

Presenter: Thomas B. Hoshizaki (thoshiz1@lakeheadu.ca)

School of Human Kinetics, University of Ottawa, Ottawa, Canada

#### **ABSTRACT**

Concussion has been reported as a common injury resulting from head impacts in cycling. High linear and rotational accelerations resulting from collisions involving the head create risks associated with concussion. The development of improved helmet technologies to better manage linear and rotational accelerations is necessary to reduce the incidence of concussion. This study involved three cycling helmets one with a rotational impact dampening system, one with a rotational and linear acceleration damping system and one a conventional helmet. The helmets were mounted on a Hybrid III headform, attached to a monorail “free drop” rig and impacted at 6.5 m/s to examine differences in peak resultant linear and rotational accelerations. The amount of brain tissue strain was also calculated for each helmet impact using the University College Dublin Brain Trauma Model. The variables measured using the brain trauma model included grey and white matter tissue strain (MPS). The results from the helmet impact tests demonstrated a dampening effect ranging from 6% to 65% for peak resultant accelerations and 4% to 25% for the brain strain values for each helmet location when using the novel technology. The outcome of this study suggests that there are opportunities to improve the protection capacity of cycling helmets for concussions using innovative technologies.

**keywords:** Injury Biomechanics, Helmet Technology, Innovation, Cycling Injuries, Concussion, Traumatic Brain Injury, Sports Concussion, Neuroscience, Finite Element Modelling

**Why a rear motor is better than a front motor & Two motors are better than One**

Author(s): Vera E. Bulsink, G. Maarten Bonnema, Dorien van de Belt, H.F.J.M. Koopman

Presenter: Vera E. Bulsink (vera.bulsink@utwente.nl)

Department of Biomechanical Engineering, University of Twente, Twente, The Netherlands

**ABSTRACT**

Electrical bicycle hub motors are frequently used to assist the cyclists pedal. However, in order to ensure the further acceptance of the electric bicycle, improvement of safety is necessary. In this study, computer simulations were used to study the effect of using electric hub motors on the bicycle's stability. The two goals of the study were to show that using a rear wheel hub motor is better than using a front wheel hub motor, and to show that with using two hub motors simultaneously the bicycle self-stability can be improved. An open-loop bicycle-cyclist model was used to study the self-stability of the system during straight cycling, by analysing the weave eigen mode of the bicycle-cyclist system. Further-more, the behaviour during cornering was analysed. The difference in self-stability of the bicycle-cyclist system with a front or rear hub motor was small in the straight cycling case; the weave speeds were quite similar. However, with the example simulation of a cornering movement it was shown that using a rear motor is better than using a front motor; traction with the rear motor stabilizes the system more than traction with the front motor did. Additionally, the computer simulations showed a decrease in the weave speed during straight cycling, when a sufficiently high traction torque was applied on the rear wheel and an equally high braking torque on the front wheel. Using two motors as an electric bicycle add-on, not only provides the benefits of the current electric bicycle, like assistance in pedalling power. It also assists in active bicycle stability control and can therefore improve the safety of electric bicycles, especially when considering older cyclists who experience more difficulties with active bicycle stability control.

**keywords:** electric bicycles, safety, stability analysis, computer simulation

**Naturalistic cycling tests with an intelligent bicycle: evaluations of a rear-view assistant and a front-view assistant.**

Author(s): Carola Engbers, Rosemary Dubbeldam, Stefanie H.H.M. de Hair-Buijssen, Esra van Dam, Lauri N.J. Bax, Jaap H. Buurke, Hans J.S. Rietman

Presenter: Carola Engbers (c.engbers@rrd.nl)

Roessingh Research & Development, Enschede, the Netherlands

**ABSTRACT**

In the Netherlands older adults continue to cycle until a higher age. However, the older cyclist (>65 years) is often victim of a single-sided accident; an accident in which no other road user is directly involved. To support the older cyclist an intelligent bicycle was developed. This intelligent bicycle consists of a rear-view assistant, which warns the cyclist for traffic approaching from behind and a front-view assistant; which warns the cyclist for traffic approaching from the front. User tests were performed with 20 cyclists from 65 years and older. The cyclists were asked to cycle on a predefined route in a naturalistic cycling environment with and without technological support from the intelligent bicycle. During this route, the cyclist was confronted with overtaking cyclists and oncoming cyclists. The participants' cycling behavior was observed on steering, sway and looking behavior. Cycling speed was measured during the user tests. Subjective measures were assessed with an interview after the test. Experienced mental workload and acceptance of the system was assessed. The participants experienced a low workload in both conditions, so with and without support. The rear-view assistant was experienced as more useful in terms of acceptance in comparison to the front-view assistant. The results of this study will be used for further development of the intelligent bicycle and can be used to enhance cycling safety.

**keywords:** elderly, cycling, user-tests

**What is the other cyclist about to do?**

Author(s): Frank Westerhuis, Carola Engbers, Marianne Meijerink, Maurice Tak, Rosemary Dubbeldam, Hans Rietman, Dick de Waard

Presenter: Frank Westerhuis (f.westerhuis@rug.nl)

Faculty of Behavioural and Social Sciences, University of Groningen, Groningen, The Netherlands

**ABSTRACT**

When cycling, it is sometimes hard to predict the intended turn of other cyclists, potentially leading to hazardous situations. Therefore, cyclists in most countries are obliged to use arm signals to point in their intended direction, although this rule is regularly ignored. Many older cyclists have difficulties keeping balance when they have to point due to the fact that they then have to steer with one hand. Goal of this study is to evaluate prototypes of a smart bicycle light, which provides information to other road users by varying in colour, intensity, or symbols, presented in both bicycle lights. By using these signals, other road users may obtain insight in a cyclists' actions such as accelerating, decelerating, turning, and braking. To study the potential of smart bicycle light in expressing intention, both older and younger participants evaluated three types of smart bicycle lights, presented as animations on a laptop. At the start of each session, one system was presented randomly between participants, while providing as little context as possible in order to assess a first naive interpretation concerning the meaning of the signals. Hereafter, evaluations of the remaining variants were assessed, by asking the participants how they perceived the comprehensibility of the signals, after the meaning was provided. The study results will be used for further development of smart bicycle lights for enhancing cycling safety.

**keywords:** Intention, Signaling, Communication

**See me save me - improving the safety of cyclists.**

Author(s): Harpreet S. Dhunna, Vinod K Kanumala

Presenter: Harpreet S. Dhunna (contact@harpreethsingh.com)

Avoid Accident NGO, Observe Road Safety Responsibly, Chandigarh Area, India

**ABSTRACT**

Cyclists are hard to be seen on the roads during night rain, fog and hazy weather. Mostly these vehicles do not have any lights which could alert the other drivers to feel their presence on roads. They especially cyclist became almost invisible during the night when head lights from other side makes driver almost blind. Description Most of the Indian population lives in rural areas and small cities. Walking and cycling remain the dominant modes of transport in small cities and rural areas.<sup>2</sup> The pedal bicyclist constitutes a significant share of total traffic on Indian roads accounting for 15-35% of total trips.<sup>3</sup> The incidence of head injuries in cyclists ranges from 14- 36% of the total injuries. We have chosen one district to make the cyclists visible on the roads. The focus is on the labor class especially and the students riding it to schools We involved traffic police and media to make it success. We choose the spot where the labor and workers with cycles are stationed. We fix high quality reflective on the cycles to make it visible on roads. And also we guide them about the driving precautions to be observed on roads riding at night and during fog. Aids to improve pedestrians and cyclist visibility have been used to avert potential collisions. Visibility aids have the potential to increase visibility and enable drivers to detect pedestrians and cyclists earlier. Fluorescent materials in yellow, red and orange colours improve detection and recognition in the daytime. Retroreflective materials enhance recognition.

**keywords:** cyclist safety, reflectives, visibility of cyclist



## S4: CONTRIBUTING FACTORS AND CRASH RISKS

### ***Overview of main accident parameters in car-to-cyclist accidents for use in the AEB-system test protocol***

Author(s): Jeroen Uittenbogaard, Olaf M.G.C. Op den Camp, Sjef van Montfort

Presenter: Jeroen Uittenbogaard (jeroen.uittenbogaard@tno.nl)

Netherlands Organisation for Applied Scientific Research, TNO, Delft, The Netherlands

#### ABSTRACT

The number of fatalities in road traffic accidents in Europe is decreasing. Unfortunately, the number of fatalities among cyclists does not follow this trend with the same rate [1]. The automotive industry is making a significant effort in the development and implementation of safety systems in cars to avoid or mitigate an imminent crash with vulnerable road users, including cyclists. The current state-of-the-art of active safety systems, Autonomous Emergency Braking (AEB), is being widely introduced. From 2018, AEB systems dedicated to avoid or mitigate car-to-cyclist collisions will be considered in the safety assessment by Euro NCAP. To support and prepare the introduction of Cyclist-AEB systems and the resulting consumer tests of such systems, an appropriate test protocol has been developed in the project CATS (Cyclist-AEB Testing System) with car manufacturers and automotive suppliers. In a previous paper [4], the most relevant accident scenarios for fatal and seriously injured car-to-cyclist collisions were identified, using an in-depth road accident study with data from Germany, the Netherlands, Sweden, France, Italy, and the United Kingdom. In this paper a description is given how the distributions for the most relevant accident parameters in the identified accident scenarios have been determined. The CATS project resulted in a test protocol, including test parameters based on the distributions for the accident parameters, and a test setup. The results of the project have been shared with Euro NCAP.

**keywords:** Autonomous Emergency Braking, Cyclist, parameters, test scenarios

### ***Contributing Factors to Bicycle-Motorized Vehicle Collisions: A Systematic Literature Review***

Author(s): Marco De Angelis, Gabriele Prati, Federico Fraboni, Víctor Marín Puchades, Luca Pietrantonio

Presenter: Marco De Angelis (marco.deangelis6@unibo.it)

Department of Psychology, Alma Mater Studiorum University of Bologna, Bologna, Italy

#### ABSTRACT

This systematic literature review aimed to identify the main factors contributing to Bicycle-Motorized Vehicle (B-MV) collisions, eventually describing the typical scenarios in which they occurred. Based on the framework design by Shepers, Hagenzieker, Methorst, van Wee & Wegman (2014), we conducted a systematic literature review following the guidelines of the Preferred Reporting Items for Systematic reviews and Meta-Analyses for Protocols (PRISMA-P, (Moher et al., 2015)). From the 8521 articles identified on the earliest stage, only studies investigating the contributing factors of B-MV collisions were included in the analysis. We included 61 in the review. Three investigators independently assessed search results for eligibility criteria: only contributing factors related to B-MV collisions; the results were disaggregated by road user and by crash opponent. Based on the Safe System, we broadly differentiated the main contributing factors identified in the literature into those involving road user's behaviors, road infrastructure, vehicle characteristics, exposure (e.g. traffic volume/safety in numbers effects) and other. This study categorizes and sheds light on the main factors involved in B-MV road accidents, therefore, these findings can be used to inform and guide policy-makers, infrastructure urban planners and vehicle manufactures in improving traffic safety and the design of active safety systems.

**keywords:** Contributing Factors, Bicycle-Motorized Vehicle Collisions, Systematic Literature Review

### ***Car-to-cyclist accidents from the car driver's point of view***

Author(s): Irene Gohl, Anja Schneider, and Marcus Wisch

Presenter: Marcus Wish (wish@bast.de)

Federal Highway Research Institute (BASt, Bergisch Gladbach, Munich, Germany)

#### **ABSTRACT**

A promising approach to prevent road traffic accidents between passenger cars and cyclists is the development of driver assistance systems. To develop such systems with maximum effectiveness in road traffic, car-to-cyclist accidents have to be analysed from the car driver's point of view to gain insight into the situations with which the drivers were faced and especially why they failed to manage these crash situations. The EU funded project PROSPECT (Proactive Safety for Pedestrians and Cyclists) considered this approach and made the pre-sented research possible. This paper reports findings from a case-by-case analysis of 3,550 car-to-cyclist accidents in Germany. The results of the accident analysis confirm findings of previous studies showing that crossing scenarios play a predominant role in car-to-cyclist accidents. Moreover, the results show that both the orientation of the cyclist and the driver's task (in terms of the driver's maneuver intention, road layout, traffic regulations) have an influence on the distribution of those scenarios in so far as certain combinations lead to a higher or lower distribution. The results contribute towards a better understanding of possible reasons why the driver failed to manage certain situations. Regarding PROSPECT, the most relevant use cases will be used to specify and develop advanced measures that will be implemented in the next generation of active safety systems.

**keywords:** car-to-cyclist accidents, crossing accidents, perceptual error, expectation

### ***Evaluation of contributory factors' effects on bicycle-car crash risk at signalized intersections***

Author(s): Peipei Liu, Stefanie Marker

Presenter: Peipei Liu (ppzhup3@hotmail.com)

Chair of Naturalistic Driving Observation for Energetic Optimisation and Accident Avoidance, Technical University of Berlin, Berlin, Germany

#### **ABSTRACT**

Bicycle-car accidents at signalized intersections account for a considerable part of bicycle accidents. Factors that have effects on the bicycle-car crash risk at signalized intersections are not well understood. Especially, the safety effects of bicycle facilities are controversial at intersections. This paper aims to identify factors that have significant effects on bicycle-car crash risk at signalized intersections and their effect directions. The negative binomial regression model is used to describe associations between the frequency of bicycle-car accidents at signalized intersections and the contributory factors, based on six-year accident history at 140 signalized intersections in Berlin, Germany. The considered factors include the traffic volume, geometric data and both bicycle-specific and car-specific infrastructures. The factor effect coefficients are estimated by the maximum likelihood approach. The estimated coefficient of the negative binomial dispersion parameter is significant at the level of 0.001. Three factors are identified as having negative effects on the cycling safety. Regarding bicycle facilities, whereas the intersections with more bicycle paths is subject to a higher crash risk, although intersection modifications are applied for bicycle paths. The results support the choice of the negative binomial regression over the Poisson regression in this study. The estimated effects provide implications for the cycling safety improvement at signalized intersections.

**keywords:** Bicycle-car crash risk, Signalized intersection, bicycle facilities, negative binomial regression.

***Safe Cycling: exploring relevant factors for cycling with low vision***

Author(s): Bart Jelijs, Joost Heutink, Dick de Waard, and Bart Melis-Dankers

Presenter: Bart Jelijs (l.h.jelijs@rug.nl)

University of Groningen, Groningen, The Netherlands

**ABSTRACT**

In the Netherlands, there are no special legal requirements with regard to vision to participate in traffic as a cyclist. To be on the safe side, individual mobility trainers of the Dutch centres of expertise for blind and partially sighted people might give advice about cycling that is too restrictive. Not so much is known about the factors that determine whether it is safe and advisable to cycle with low vision. To reach consensus on what functions and issues are relevant for cycling with low vision, a Delphi study was conducted. In two rounds, a panel of 46 experts on cycling and/or vision was asked to indicate relevant environmental, personal, and visual factors for cycling with low vision. Firstly, each panel member gave suggestions by answering both open-ended and multiple choice questions, which were presented using online survey software. All of the collected suggestions were categorised into sub factors. During a second round, each expert was asked to rank these sub factors in order of importance. This study resulted in an overview of all (sub) factors that are relevant for cycling with low vision. According to the panel, the most important factors are: traffic situation, infrastructural characteristics, personality, and traffic experience(s). Glaucoma and macular degeneration are considered the main visual impairments that lead to a decrease in bicycle usage among partially sighted people.

**keywords:** cycling, low vision, Delphi study

***One degree of separation: The influence of cyclist position on risk of injury***

Author(s): Brendan Lawrence, Jennifer Oxley, Mark Stevenson, and David Logan

Presenter: Brendan Lawrence (brendan.lawrence@monash.edu)

Accident Research, Monash University, Clayton, Melbourne, Australia

**ABSTRACT**

The number of cycling injuries in Australia is increasing, and a high proportion occur on the roads in major cities. Little is known about how the cyclist is positioned on the road in the urban environment. This study examined the cyclists' position on the road at crash locations, and locations identified through an exposure study. The cyclists' position on the road before a crash event was identified through a hospital-based interview. It was coded by the road facility used by the cyclist, and the type of road uses to their left and right. This was compared to the position of cyclists at on-road locations identified through a geographically comparable exposure study. Differences in the positions between the groups were assessed using a chi-square test statistic. Statistically significant differences were found between the positions of cyclists between the groups. The standardised residuals indicated cyclists of the crash sample were observed between on-street parking and a shared traffic and tram lane, more often than what might be expected (the exposure group). Before the crash event, cyclists were positioned between on-street parking and a shared traffic and tram lane, more often than what might be expected. In many cases, they were cycling in a space available to cyclists, but not formally marked as a bike lane. The risk of 'dooring' and the hazard presented by tram tracks, presents a unique challenge to cycling safety practitioners.

**keywords:** Infrastructure, Position, Urban

## S5: INTERACTION BETWEEN CYCLISTS AND DRIVERS

### ***Drivers' gap acceptance and TTA judgements when confronted with approaching bicycles, e-bikes and scooters***

Author(s): Katja Schleinitz, Tibor Petzoldt, Tina Gehlert

Presenter: Katja Schleinitz (katja.schleinitz@psychologie.tu-chemnitz.de)

Chemnitz University of Technology, Chemnitz, Germany

#### ABSTRACT

For drivers it is vital to choose safe gaps when turning in front of approaching vehicles. Crucial for this decision is the time remaining before the approaching vehicle arrives (time to arrival, TTA). Previous studies have shown that the size of the vehicle can influence the size of accepted gaps as well as the TTA estimates. Drivers have been found to choose smaller gaps and provide longer TTA estimates when confronted with smaller vehicles, e.g. compact cars, compared to larger ones, e.g. trucks [1], [2]. While object size alone might explain this result [3], others suggest that the effect of vehicle size is rather caused by the potential threat ascribed to the approaching vehicle [4]. To assess the merit of these potential explanations, size and threat of the approaching objects need to be disconnected, e.g. by using vehicles that are similar in size, but differ in the potential threat they pose to the driver of a car. In the experiment reported in this paper, we used different types of two-wheelers (bicycle, e-bike, scooter) that are of roughly the same size, but differ substantially in the potential threat they pose. Participants were presented with video sequences of approaching two-wheelers, and were required to either indicate the smallest acceptable gap for a left turn in front of the vehicle, or to estimate TTA in two different experimental blocks. The results show that participants accepted smaller gaps for the two bicycle types than for the scooter, whereas there was no difference between the bicycles. Likewise, TTA estimates for the two bicycles were longer than those for the scooter. These results indicate that certain characteristics of the vehicle unrelated to physical size, such as the potential threat the vehicle poses, play a role in the assessment of a vehicle's approach. This implies that other road users might show an increased willingness to select potentially risky gaps when turning in front of bicycles and e-bikes in real traffic.

**keywords:** gap acceptances, time-to-arrival, size arrival effect

### ***Influence of peloton configuration on the interaction between sport cyclists and motor vehicles on two-lane rural roads***

Author(s): Carlos Llorca, Jorge Serra, Alfredo Garcia

Presenter: Carlos Llorca or Alfredo Garcia (carlloga@cam.upv.es)

Highway Engineering Research Group, Universitat Politècnica de València, Valencia, Spain

#### ABSTRACT

Cycling is a common activity on Spanish two-lane rural roads, mainly associated to sport and leisure. Cycling on rural roads resulted in 54 deaths in 2014 in Spain. Past research in the Netherlands found that riding in a peloton was a significant factor, contributing to increase bicycle crashes. However, there is no scientific evidence of the advantage of riding in a peloton, in terms of risks associated to the interaction with motor vehicles. According to Spanish regulations, up to two cyclists can ride in parallel on a two-lane road. This study compared different peloton configurations riding on a two-lane rural road segment. Up to three amateur cyclists participated in this experiment. They rode along a road segment individually and grouped in pelotons with pre-set configurations, repeating the same itinerary for each configuration. Those were: single bicycles, 2 bicycles in parallel, 2 in line, and different groups of three cyclists. Motor vehicle overtaking were observed and characterized from video cameras installed in the bicycles; speed and clearance were

measured thanks to laser rangefinders on board. Moreover, the subjective risk perception at every overtaking event were recorded. Objective and subjective measures identified risky overtaking manoeuvres, related with low lateral clearances, high speed of vehicles or high risk perception. These provided scientific support for criteria to ride in a peloton on two-lane rural roads.

**keywords:** bicycle, sport cycling, peloton, two-lane rural road, overtaking, speed, lateral clearance, risk perception.

### ***Road safety on cycling roads and on one-way streets with contra-flow cycling***

Author(s): Marcel Schreiber

Presenter: Marcel Schreiber (m.schreiber@gdv.de)

*Department of Road Planning and Operation, Technische Universität Berlin, Berlin, Germany*

#### **ABSTRACT**

The German Insurers Accident Research (UDV) of the German Insurance Association (GDV) carried out a research project on the traffic safety of cycling roads and one-way streets with permitted contraflow bicycle traffic. In the project a literature review, an online survey, accident analyses, behavioral observations and surveys of road users were conducted. The analyses showed that both types of infrastructure are relatively safe in principle. Nevertheless, typical accidents were noticed. At the intersections of both predominantly turning or crossing accidents occurred. On the road segments in cycling roads bicycle accidents happened mainly in connection with parked cars or overtaking and in the one-way streets with pedestrians crossing the road. On basis of the results of the analyses it is recommended that the access for motorized road users into cycling roads has to be restricted as far as possible (i.e. access for residents only). In order to avoid overtaking of cyclists by cars without the necessary safety distances cycling roads should have a width of 4 m plus the required safety distances to parked vehicles. Furthermore cycling roads should have the right of way at intersections. In consequence the crossing roads must be recognizably designed to give way to the traffic on the bicycle road. If the conditions above cannot be met, the establishment of a cycling road has to be questioned. For one-way streets the current requirements in the legal and planning regulations for the permission of contraflow bicycle traffic in essence could be confirmed.

**keywords:** Road safety, cycling roads, one-way streets, contraflow bicycle traffic

### ***Drivers' comfort zone boundaries during overtaking of bicycles in Japan***

Author(s): Giulio F. Bianchi Piccinini, Sajad Fatahtooei Nejad, Ahmad K. Makhtar, Huiping Zhou, Makoto Itoh

Presenter: Giulio F. Bianchi Piccinini (giulio.piccinini@chalmers.se)

*Accident Prevention Group, Chalmers University of Technology, Göteborg, Sweden*

#### **ABSTRACT**

The number of bicycles owned in Japan is increasing since 1970s and about 11% of people use the bicycle to commute to work or school. As a drawback, cyclists account for a large share of all fatalities in Japan (16%), and, additionally, the fatalities figures increased by 7% from 2012 to 2013. Among the possible conflict scenarios, crashes in rural roads might be more severe than in urban roads and situations when a motorist may overtake a slower bicycle have an increased likelihood to lead to severe injuries. Although studies have been conducted on the topic, more research is required to assess the ideal comfort zone boundaries for drivers and cyclists during the overtaking maneuver, especially for the proper setting of warnings or autonomous interventions of active safety systems. In order to better understand the driver's decision process during overtaking of bicycles, an experiment was conducted in the fixed-base driving simulator at University of Tsukuba. Overall, 40 participants were recruited and divided in two groups: 20 younger drivers



(25-40 years old) and 20 elderly drivers (65-75 years old). The participants were asked to drive on a rural route and overtake a bicycle in the simulated environment. The preliminary analyses show that no differences were found between the two groups of drivers for comfort zone boundaries during the approaching phase (defined as the phase ending when the driver starts to steer away to get out of the collision path).

keywords: driving simulator, comfort zone boundary, overtaking maneuver

***Analysis of Bike Crashes using RANKERS, a web-based application for identifying practical solutions to mitigate crash risk***

Author(s): Maurizio Tira, Michelle DeRobertis, Fahad Anwar

Presenter: Maurizio Tira (m.derobertis@unibs.it)

*Department of Civil Engineering, Architecture, Land and Environment, University of Brescia, Brescia, Italy*

**ABSTRACT**

The RANKERS (RANKing for European Road Safety) crash analysis tool helps practitioners develop appropriate countermeasures for automobile crashes with only the limited information available from statistical databases. This web-based application is based on the American-developed “Crash Type” and the French “prototypical accident scenarios”. RANKERS developed over 100 scenarios which consider all four elements of a typical road collision, establishing a connection between road characteristics and accident risk. A decision-tree helps users arrive at appropriate solutions for the given crash scenarios. Each scenario is associated with a number of known countermeasures identified from published literature, research by others and the experience of the researchers. The research unit of the University of Brescia incorporated bicycle and pedestrian countermeasures into the tool, which was tested by the Province of Brescia and the London Road Safety Unit of the Transport for London. These agencies found that RANKERS was a beneficial tool from both an operational and educational point of view. This paper describes the RANKERS crash analysis tool, which facilitates the identification of appropriate countermeasures for bicycle crashes, as well as for other users. It is a very useful and efficient way for cities to develop countermeasures, infrastructure, education as well as enforcement, to improve the safety of bicyclists on European roadways.

**keywords:** Road safety, cyclists, accident scenario

## S6: SAFETY EDUCATION AND ADOLESCENT CYCLISTS

### ***A quasi experimental evaluation of a long-term school-based bicycle helmet campaign for children aged 4-8 years in the Netherlands***

Author(s): Marjolein Boele-Vos, Charles Goldenbeld, Jacques Commandeur and Divera Twisk

Presenter: Marjolein Boele-Vos (marjolein.boele@swov.nl)

Road Safety Assessment, SWOV Institute for Road Safety Research, The Hague, The Netherlands

#### ABSTRACT

The risk of head injury from a bicycle crash is higher for young children than for adults. Although head injury severity may be reduced by a helmet, helmets are not mandatory in the Netherlands. Yet public support for voluntary use of bicycle helmets for children is high and there is great interest in school based helmet promotion programmes. This study evaluated the effect of a 5-year school-based campaign (for 4 to 8 year olds) on helmet wearing rates and identified its success and fail factors. The programme provided free helmets and education for each child, as well as information for their parents. The evaluation study compared observed helmet wearing rates before the campaign, with yearly rates during the five-year programme, and related those to wearing rates in a control area. Parents, together with their children, completed questionnaires on self-reported helmet wearing, attitudes, beliefs, and barriers. The results showed that observed bicycle helmet wearing increased in the first campaign year, but varied in later years. This variation in rates coincided with variations in campaign intensity over the years. Factors associated with self-reported helmet wearing were children's age, with higher wearing rates for younger children than older children, and parental rules for helmet use. Children and parents are positive towards helmet use when children are perceived to be less competent cyclists. The most important reason for not wearing helmets is that peers do not wear helmets. Overall, parents and children may thus be influenced by the norm in the Netherlands that children above a certain age cycle without a helmet.

**keywords:** free bicycle helmet, school-based campaign, follow-up, evaluation

### ***Peer distraction: an experiment to assess impact on adolescent and adult cyclist's hazard perception performance***

Author(s): Divera Twisk, Elcke de Geus, Willem Vlakveld

Presenter: Divera Twisk (divera.twisk@swov.nl)

SWOV Institute for Road Safety Research, The Hague, The Netherlands

#### ABSTRACT

Young adolescent cyclists - 12 to 14 years of age – are a highly vulnerable group of road users, due to the high injury risk of bicycles, inexperience and immaturity, and distraction. This study explored the interaction between hazard perception (HP) performance - visual search, hazard localisation and decision making - age (inexperience) and distraction. It hypothesized that: a) young adolescent would be worse in HP than adults (H1), b) for both age groups, HP would deteriorate when distracted (H2) and c) interference of distraction with HP would be greater for adolescents than for adults (H3). In this counterbalanced experiment, with age as a between subject factor and distraction as a within subject factor, HP was measured as the performance on a task consisting of traffic videos clips from a cyclist's perspective. The distraction task consisted of a peer delivered captivating distraction task: a 'guessing game'. The results showed that age differences were only apparent in hazard decisions. Adults assessed more frequently a situation as being hazardous than

adolescents did (H1). Further, in both age groups hazard localization and decisions were both negatively affected by distraction (H2), whereas visual search was not. The expectation that adolescents would be more affected by distraction than adults (H3) was only confirmed for the frequency by which situations were seen as hazardous (hazard decisions). Although the current HP task needs further improvements, its results are supporting high risks of distraction showing its negative effects on hazard decision making. It further revealed an even greater negative impact on the hazard decision making by the highly vulnerable young adolescent cyclist.

**keywords:** Experiment, Distraction, Hazard perception, Adolescents, Cyclists, Instrument development

### ***Where people pay attention while cycling? A comparison of adults and children.***

Author(s): M.C. Melin, E. Peltomaa, L. Schildt, H. Hoffmann, E. Lehtonen

Presenter: Marianna Melin (esko.lehtonen@helsinki.fi)

*Institute of Behavioural Sciences, University of Helsinki, Helsinki, Finland*

#### **ABSTRACT**

Cycling in urban environments requires ability to distinguish between relevant and irrelevant targets in a fast and robust manner, so that potential hazards can be anticipated and avoid-ed. In two studies, we investigated where do adults and children pay attention to when viewing videos filmed from a cyclist's perspective. In the 1st study, 16 adults (19–33 years) were asked to watch 10 videos and to point out things they would pay attention to by using a touchscreen. They were also asked to explain their answers afterwards. In the 2nd study, 17 adults (19–34 years) and 17 children (11–12 years) performed the same task with the same 10 videos and 20 additional videos, but they were not asked to explain their answers afterwards. Data from two experiments was pooled and three groups, 10 experienced adult cyclists, 23 inexperienced adult cyclists and 17 children, were formed. We investigated the number of pointed out locations and their distribution between the three groups. We also investigated the horizontal and vertical spread of the pointed out locations. In addition, we selected 10 clearly visible, traffic relevant targets from the videos and investigated if the participants had hit them. The adults pointed out more locations than children. Adults were both faster at hitting at the prespecified targets and they missed them less of-ten. Children had a larger vertical dispersion and larger between participant variation than the adults. The differences between inexperienced and experienced adults were in the ex-pected direction, but not significant. The results suggest that children have a less developed ability to distinguish what is relevant in traffic. Caution is needed when making any predic-tions of children's performance based on studies among adults, because children may not behave like inexperienced adults.

**keywords:** situation awareness, hazard perception, children

### ***Route Choice of 10-15 Year Old Cyclists to School: Implications for Safe Routes Infrastructure***

Author(s): Steven P. Spears, Cara J. Hamann

Presenter: Steven P. Spears (steven-spears@uiowa.edu)

*School of Urban and Regional Planning, University of Iowa, Iowa City, United States*

#### **ABSTRACT**

Localities have invested in bicycle infrastructure near schools to improve safety and encourage physical activity. However, little is known about factors that influence child bicycling route choice and use of bicycle lanes and sidewalks on school trips. The purpose of this study was to examine factors that influence child route choice. Child bicycling behaviour was naturalistically observed over a one week period. Trips were

recorded with a helmet camera and GPS. Routes were analysed at street segment level for traffic volume, gradient, and bicycle/pedestrian friendliness (using a modified version of MAPS-Mini). School trips were evaluated for 34 children aged 10 to 15. Route length ranged from 0.4 to 13 km (median 1.59). Median traffic level on chosen routes was 1836 veh/day (min 144, max 6307). This compares to a median of 623 veh/day (min 0, max 31,800) for all road segments within 3 km of participant school sites, indicating that children travel streets with moderate traffic levels as part of their daily cycling to school. Strategies such as sidewalk riding and detours to marked/guarded crosswalks were used to traverse higher traffic road segments. Children tend to choose school travel routes that have moderate traffic levels and use strategies that include sidewalk riding to cope with perceived on-road risks. Such strategies may expose children to greater risk, and should be considered in both infrastructure design and education.

keywords: naturalistic, school, children

### ***Characteristics of bicycle crashes in an adolescent population in Flanders (Belgium)***

Author(s): Jef Vanparijs, Luc I. Panis, Romain Meeusen, Bas d. Geus

Presenter: Jef Vanparijs (jvparijs@vub.ac.be)

*Department of Human Physiology, Faculty of Physical Education and Physical Therapy, Vrije Universiteit Brussel, Brussels, Belgium*

#### **ABSTRACT**

Air pollution and traffic congestion are rife. Active transportation such as cycling might be a solution but safety is a major concern. An efficient science based safety policy arises. The aim of this paper is to analyze in depth the bicycle crash causes and characteristics in an adolescent population. By using questionnaires for self-reported bicycle crashes, bicycle crash data were collected from insurance companies and from schools. Six bicycle crash causes were predefined and possible differences between schools and insurance companies were analyzed. "Distraction of the cyclist" and "third party crossing a bicycle path failing to see the cyclist" are the main causes of bicycle crashes (29%). Bad maintained infrastructure accounted for 21% of the crash causes. Bicycle crashes reported at insurance companies needed significantly more medical attention and had high absenteeism. Only 21% of the bicycle crashes reported at insurance companies were also reported in the official police database. The human factor is the main cause accounting for 79% of the crashes. Rather than focusing solely on the human behavior, changing the bicycle specific environment might reduce the consequences of human errors. These changes need to be based on all cases, relevant for society. By Incorporating data from insurance companies in national statistics this goal can be achieved and lead to a better decision making of the policy makers.

keywords: safety, crash causes, adolescents

### ***Parent-child bicycling safety communication concordance***

Author(s): Cara J. Hamann, Steven Spears, Matthew Van Hoeck, Ryan Dusil

Presenter: Cara J. Hamann (cara-hamann@uiowa.edu)

*Department of Occupational and Environmental Health and Injury Prevention Research Center, University of Iowa, Iowa City, United States*

#### **ABSTRACT**

Efforts to encourage child bicycling to school have increased in the United States. However, little is known about parent-child communication about bike safety. The purpose of this study was identify and examine parent-child agreement on biking instructions. Parent-child dyads were asked open-ended questions about

instructions that they had given/received about bicycling. Answers were then coded into 25 instruction types. Distributions as parent-child agreement were examined. 40 parent-child dyads were included. Average age was 11.9 (SD = 1.5, range 10 to 15) for children and 42.8 (SD=6.4, range 28 to 59) for parents. Common types were: wear helmet, ride on sidewalk, intersection crossing caution, and trip routing. High 'ride on sidewalk' instruction (35.1% both parent and child, 16.2% parent only, 18.9% child only) was of concern, given it is a known crash risk factor. The majority of topics were caution/avoid in nature (e.g., busy streets, driveways, pedestrians). Agreement on parent-child reported instructions was low, overall, with the exception of helmet use ( $\kappa=0.59$ ,  $p$

**keywords:** children, parent-child agreement, safety communication

### ***A Fundamental Study about Cycling Safety Education using a Cycling Simulator***

Author(s): M. Suzuki, K. Sato, K. Hosoya, K. Miyanoue, T. Yai

Presenter: Mio Suzuki (mios@enveng.titech.ac.jp)

*Department of Built Environment, Tokyo Institute of Technology, Tokyo, Japan*

#### **ABSTRACT**

Traffic accidents with cyclists who know the rules but violate them are considered as one of serious social problems, but the methodologies to safety education for cyclists has remained to be defined. So in this study, we revealed the effects and the feasibility –reproducibility of cycling behavior with law violation, especially- of the experience-based education program using a cycling simulator "MORICS1". As the results, the effects of the safety education programs depend on the accident experience itself and the evaluation of "MORICS1". And then we conducted the experiment survey with that after the braking system was improved, and it was revealed that the safety education program with the cycling simulator can make those who know the rules to reproduce the behavior with the law violation.

**keywords:** Safety education, cycling simulator, braking behavior, law violation



## POSTER SESSION

### ***Public Authorities and the High School Student's Community. Case study for sustainable mobility with Bicycle***

Author(s): Smaragda Chrysoulaki

Presenter: Smaragda Chrysoulaki ([chrysoul.john@gmail.com](mailto:chrysoul.john@gmail.com))

Athens, Greece

#### ABSTRACT

Nowadays we need to see urban development through a sustainable perspective. This perspective requires environmentally friendly transport options as well as human-centered and sustainable cities. A sustainable city needs more pedestrians, more bicycles, more green areas and fewer cars. Students, with the support of public administration authorities, can be great advocates of bicycling as a principle mode of transport. For this reason, the writers of this study have taken the initiative to create a website and an online forum in order to promote sustainable mobility in Greek cities. Through this electronic platform students have started joining the "Students Community for Sustainable Mobility". In collaboration with local authorities and societies, the Students' Community will present its initiatives, exchange views, network, and share advice. This study aims to connect student communities with public administration authorities in order to promote sustainable mobility and student use of bicycles in Greek cities. This aim will be achieved if students who are interested in sustainable mobility join the online platform and network through Facebook. It is expected that this project will be the greatest goal ever achieved by the Students' Community for Sustainable Mobility. Students who become members will participate in the European community "Do the right mix", connect with other European members through Facebook, and alongside Greek municipalities, organize the promotion of environmentally friendly mobility around Greece. Members will also be in touch with local authorities and societies as well as other students in order to organize events, teleconferences and webinars that will promote the idea of sustainable mobility to every Greek school.

**keywords:** bicycle, internet, community

### ***Learning game improves child and adult cyclists' situation awareness***

Author(s): Esko Lehtonen, Jasmiina Airaksinen, Anna Rissanen, Riikka Ränninranta, Veera Åberg, Heikki Summala

Presenter: Esko Lehtonen ([esko.lehtonen@helsinki.fi](mailto:esko.lehtonen@helsinki.fi))

Institute of Behavioural Sciences, University of Helsinki, Helsinki, Finland

#### ABSTRACT

Situation awareness is basis for hazard anticipation, which is essential for safe cycling. Previous studies have indicated that children have less developed skills for acquiring situation awareness which can expose them to greater risk while cycling. In this study we investigate if child and adult cyclists' situation awareness can be improved with a video based learning game. 36 children (9-10 years) and 22 adults (21-48 years) played a learning game and their eye movements were recorded. The game had 30 video clips filmed from cyclists' perspective presented in random order. Players had to monitor the traffic situation for relevant targets which could affect their riding or safety. In each clip, the video was suddenly masked and 2 to 3 locations were presented on the screen. The player had to choose those locations where was something relevant. Feedback was given via text, sounds and points. Both children and adults improved their response accuracy over the 30 video clips. Adults performed better than children as expected. Adults had also more fixations to relevant targets, which suggest that they anticipated more. In general, children regarded the the learning game positively. The results suggest that the learning game could be an effective way to improve child cyclists' situation awareness, and thus improve their cycling safety. Further research is needed to investigate transfer of learned to real cycling.

**keywords:** situation awareness, hazard perception, serious games

### ***Comprehensive cycling educational programme for children: Slovene experiences***

Author(s): Mateja Markl, Bojan Oblak

Presenter: Mateja Markl (mateja.markl@avp-rs.si, markl.mateja@gmail.com)

Slovenian Traffic Safety Agency, Sector for drivers, Ljubljana, Slovenia

#### **ABSTRACT**

In Slovenia we have established years ago comprehensive educational programme for learning cycling for children in primary school, which is included in curriculum. In the present study we have made an analysis of different systems in some included European countries regarding the cycling training for children and compared it to the recommendations of different authors and results of the international projects (ROSE 25, SUPREME, BIKE2SCHOOL). In Slovenia the cycling training for children have 3 parts: theoretical part and exam, practical training of skills on school-ground and riding in traffic and practical exam. Re-cently we have introduced new computerised theoretical part of the cycling exam for children in primary school. In the study we have analysed the results of children on cycling training and main mistakes, that they have troubles with. After the cycling exams there we organise local and national programme of cycling competitions What do you know about traffic for children (12 – 15 years) involving primary schools on national level. We have analysed the involved children in the web-system and their performance at the theoretical tests, and also by different characteristics as age, sex, urban/non-urban schools, etc. Also we have introduced a web-questionnaire regarding the involvement of schools in cycling training. The results show that almost all primary schools (N= 207, which represent around 50% of all Slovenian primary schools) are involved in the web-system, that 95 % of them have specially educated teacher for cycling training, and that they spent around 25 hours for theoretical part.

**keywords:** cycling training, children, web-portal

### ***The YOLO prevention program – Promoting adolescents' cycling safety through executive function training***

Author(s): Andrea Ludwig, Stefanie Y. Schuler, Anika Fäsche, Wiebke F. Evers

Presenter: Stefanie Y. Schuler (stefanie.schuler@znl-ulm.de)

University of Ulm, Ulm, Germany

#### **ABSTRACT**

For German adolescents cycling accident rates escalate between age 10 to 14. The YOLO prevention program focuses on strengthening puberty related neuropsychological aspects, e.g. increased risk taking and immature executive functions (EF), in order to promote cycling safety. In a first step, characteristics of adolescents at risk were identified using data of 1024 students between 10 and 15 years regarding cycling accidents, risk-taking (JTCl; Goth & Schmeck, 2009), peer influence (RPI; Steinberg & Monahan, 2007) and EF (BRIEF; Drechsler & Steinhausen, 2013). Latent profile analyses, amongst others controlling for multilevel structure of data, revealed two profiles (L-M-R adjusted LRT = 1050.02,  $p < .00$ ): Adolescents in profile 1 (n=710) were more likely to report adequate EF and risk-taking and less peer influence than those in profile 2 (n=314). There were only 8% of profile 1 versus 19% of profile 2 adolescents reporting more than 10 accidents since their ninth birthday. Consequently, the developed 15-week YOLO prevention program for 6th and 7th graders aims at fostering EF and self-regulatory competences. Adolescents are further encouraged to test their abilities and limits in social-emotional, cognitive and physical tasks in order to raise their awareness of risky behaviour. The program is evaluated by measuring aspects such as EF, risk-taking and cycling behaviour via questionnaires and neuropsychological tests. Evaluation results will be presented on the poster.

**keywords:** cycling safety prevention, executive function training, adolescence

***A model of factorial analysis: reasons for using a helmet in a sample of non-competitive Italian cyclists.***

Author(s): Ottavia E. Ferraro, Chiara Orsi, Cristina Montomoli, Anna Morandi

Presenter: Ottavia E. Ferraro (ottavia.ferraro@unipv.it)

Centre of Study and Research on Road Safety, Section of Biostatistics and Clinical Epidemiology, Department of Public Health, Experimental and Forensic Medicine, University of Pavia, Italy

**ABSTRACT**

The increased use of the bicycle for transport as an alternative to motorized vehicles has by now become a common occurrence in all Italian cities. Even though the benefits of using a helmet to protect against trauma in bicycle accidents have been demonstrated, its use is still not widespread. The objective of this study is to analyze those features of helmets that can influence their adoption. The data was gathered through an Internet questionnaire in collaboration with the Federazione Italiana Amici della Bicicletta (Friends of the Bicycle Italian Federation), an association of recreational cyclists. The factorial analysis was based on the statements regarding the perceptions of and use of the helmet. The factors were then analyzed through a points allocation system and compared according to type and area of residence. The sample was made up of 1,781 individuals, with a declining participation rate from North to South; 63% of respondents were men. Three factors were identified from the sample: the use of the helmet as a safety benefit; the helmet being perceived as a hindrance; and use of the helmet out of habit as well as to follow the virtuous example of friends and/or acquaintances during cycling outings. The major differences involved both the type and area of residence with respect to the perception of the helmet as a hindrance ( $p < 0.001$ ) and its use out of habit ( $p < 0.001$ ). In such a homogeneous population of respondents in terms of a passion for cycling, the opinions regarding the helmet were disparate from the point of view of the perception and consequent use of the helmet.

**keywords:** perception of bicycle helmet, safety behaviours, factorial analysis

***Cyclists: vulnerable and powerful road users – new insights into the safety debate on cycling***

Author(s): Elisabeth Füssl

Presenter: Elisabeth Füssl (elisabeth.fuessl@factum.at)

FACTUM Chaloupka and Risser OG, Wien, Austria

**ABSTRACT**

The current study is focusing on the understanding of interactions of cyclists with other road users and the impact of these interactions on traffic safety. One of the main interests are the power relations in traffic between vulnerable road users and motorized vehicles [1,2]. Given the fact that people use alternately various modes of transport in their daily lives and are consequently both cyclists and car drivers, rigid categories, like “cyclist” and “car driver” lack the analytical value for analysing interaction processes. Accordingly, the selected topic of exploration was the individuals’ perception of power relations in traffic and the interrelation of acting and self-perception. This was done by conducting 15 in-depth interviews. Many of the well documented problems between cyclists and car drivers have been frequently mentioned in the interviews, like recklessness of car drivers who overtake with narrow margin or passing with high speed or tailgating. Nevertheless, several “cyclists’ strategies” which cyclists apply in order to demonstrate their power in traffic were identified together with “cooperation strategies” between cyclists and car drivers. Our findings intend to ignite the debates about cycling safety, and promote the differentiated demands of cyclists. The pro-cyclist perspective of the findings can also be used as a base for elaboration of efficient policy measures, like adaption of road traffic regulations or cycling promotion strategies.

**keywords:** interaction strategies, power relations, policy measures

***Abandoned Rail Tracks as an Opportunity for Cycling Safety: Examples from the Czech Republic***

Author(s): Michal Bíl, Martina Bílová, Marek Sova

Presenter: Michal Bíl (michal.bil@cdv.cz)

CDV - Transport Research Centre, Brno, Czech Republic

**ABSTRACT**

The Czech railway network ranks among the densest in the entire world. The majority of the railways were built before 1918, however. Only a few of them, which form the backbone of the network, were modernized as of 1989 to allow for faster train connections. The numbers of local tracks, particularly in rural areas, were in contrast completely abandoned (1,337.7 km). 20 rail-tracks with an overall length of 127.4 km (9.5 % of the abandoned tracks) currently exist in the Czech Republic. Abandoned tracks are often completely removed, including embankments. Cycling paths represent one way of utilizing the old tracks. We studied traffic crashes on adjacent roads before and after the respective rail-tracks open-ings. The results indicate a significant drop in crashes as many cyclists began to use them in-stead of roads. Commuting and leisure-time cycling are the primary activities on current rail-tracks as follows from questionnaires among users and administrators. Rail-tracks are logically separated from road traffic, have gentle slopes and asphalt pavements. The above-mentioned facts mean that these lines are a safe and comfortable substitute for roads when commuting. A number of the current rail-tracks are situated in attractive regions and therefore these structures are also used by tourists. The fairly complicated process of conversion from railways to rail-tracks including unclear leg-islation still impedes greater utilization of this new form of cycling.

**keywords:** Rail-tracks, Safety***New road regulations for cyclists at traffic lights : what is the safety impacts ?***

Author(s): Thomas Jouannot, Pierre Toulouse

Presenter: Thomas Jouannot (thomas.jouannot@cerema.fr)

Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement – CEREMA, Bron, France

**ABSTRACT**

Since 2012, French regulations for road signage have given local authorities, when they consider it possible, tools to allow cyclists not to come to a stop at an intersection with lights before turning right or going straight on. Permission for cyclists to go through a red light in order to turn right or continue straight on meets with the objective of making it easier for these users to keep moving by avoiding stops that waste time and make it difficult to restart, while fully meeting the requirements of traffic safety for all road users. This measure has been positively evaluated in Strasbourg, Bordeaux and Nantes [1], in a regulated environment. Based on this evaluation, more than 8000 traffic lights have been equipped in France with plaques that represent an outline of a bike and show the permitted direction. The French national active mobility plan extended this measure in September 2015, to allow other movements at red traffic light, like turning left, or riding in any direction.

**keywords:** cyclists and red lights, new road regulations, safety impacts

### ***Use of Cycling Helmets: an Overview from the Crash Time-Series 1995 – 2015***

Author(s): Michal Bíl, Richard Andrášik, Martina Bílová, Jan Kubeček

Presenter: Michal Bíl (michal.bil@cdv.cz)

CDV - Transport Research Centre, Brno, Czech Republic

#### **ABSTRACT**

A generally low use of cycling helmets has been observed in the Czech Republic. It was originally not obligatory to wear a cycling helmet. The first change in the law, when cyclists under 15 had to wear helmets, was enacted in 2001. Five years later (2006) the threshold for compulsory helmet wearing was moved to 18 years of age. No complete research on the percentage of helmeted cyclists has been carried out as yet. Only local unpublished studies indicate that cyclists use helmets more often during leisure-time activities than when commuting. These two groups of cyclists only intersect to a minor extent. We studied cycling helmet use from a crash time-series as we believe that, to a certain degree, crash records data reflects the overall percentage of helmet use. The data over the period 1995 – 2015 consist of 2,036 fatal, 11,463 severe and 66,881 light injuries. The remaining 15,865 crashes were without injuries. The results indicate a gradually increasing percentage of helmeted cyclists, in general, with three distinct transitions to a higher level in 2001, 2006 and 2011, in particular for cyclists under 15. The highest percentage of helmeted cyclists was recorded with the less than 15 years of age group reaching 50 %. The lowest helmet use was noted with the group of oldest cyclists (above 64). The data also indicates that older cyclists are more prone to serious injuries.

**keywords:** Helmet use, Legislation, Crash,

### ***Mandatory helmets for special groups of cyclists? Exploring the risk and helmet wearing rates of racing cyclists, e-bikers and mountain bikers***

Author(s): Birgit Salamon, Alexandra Kühnelt-Leddihn, Armin Kaltenegger

Presenter: Birgit Salamon (birgit.salamon@kfv.at)

Austrian Road Safety Board (Kuratorium fuer Verkehrssicherheit, KfV), Wien, Austria

#### **ABSTRACT**

In 2011, Austria introduced an obligation for children below 12 to wear bicycle helmets. An evaluation showed that this measure was successful, leading to a decrease in head injuries. Five years later, a study investigates the possibility of expanding the obligation to other groups of cyclists with a presumably higher than average risk of accidents and particularly head injuries, namely racing cyclists training on roads, e-bikers and mountain bikers. The study aims at exploring various parameters that indicate a higher risk for these groups, such as speed, exposure, accident rates, and injury types. It includes an accident analysis, data collection on cyclists' speed and helmet wearing rates, a survey and focus groups. First results show that all three selected groups reach higher average speeds than other cyclists, but the difference is small for mountain bikers and e-bikers. Helmet wearing rates are much higher when cycling is practiced as a sport. Clothing proved to be a better indicator for this than the type of bike: 85% of cyclists in sportswear use a helmet, compared to 21% of cyclists in everyday clothes. Results show that while helmets are already widely in use among the selected groups, speeds are also higher, stressing the importance of helmets. However, it is too early for further conclusions since exposure data, accident rates and head injuries are still being investigated. The full results will be available for the conference.

**keywords:** bicycle helmets, accident risk

### ***Use of cycling helmet - results of the analysis in Slovenia***

Author(s): Mateja Markl

Presenter: Mateja Markl (markl.mateja@gmail.com, mateja.markl@avp-rs.si)

Slovenian Traffic Safety Agency, Sector for drivers, Ljubljana, Slovenia

#### **ABSTRACT**

Cyclists are as vulnerable road users a special target group regarding the Slovenian National Programme for road safety 2013-2022 (2013). The different researches show that the use of bicycle helmet reduces the potential seriousness of head injuries at crashes of cyclists by on average of 40 % (McNally, Whitehead, 2013) or even up to 74 % (Bambach at., 2013). We have prepared the model of observations for helmet use in different locations through Slovenia and including also the different type of roads (urban, regional). The observations were taken in April 2016 and again in June 2016. In the meantime there will be local media campaigns going on promoting the use of cycling helmet among cyclist. At the same time we were interested also in patterns about the use of cycling helmet among cyclist regarding the age, sex, type of road, hour of the day and weather. First results show that there is only 15 % of cyclists in urban areas using the helmet, the proportion for kids is much higher, and it counts almost 80 %. On regional roads, there are much less everyday cyclists, and also the proportion of the use of helmet is around 50 %. Beside that we've been promoting the use of helmets (action "Smart head uses helmet"), organizing different preventive events (showing the necessity of the helmet use), prepared and disseminate different preventive and promotional materials (cycling helmets, lights, brochures, educational video and review of best practices).

**keywords:** helmet use, observation, injuries

### ***Cyclists' eye movements at uncontrolled intersections: An eye-tracking study using animated video clips?***

Author(s): Natália Kováčsová, Christopher D.D. Cabral, Stijn J. Antonisse, Taeke de Haan, Rick van Namen, Jochen L. Nooren, Rutger Schreurs, Marjan P. Hagenzieker, Joost C.F. de Winter

Presenter: Natalia Kovacsova (n.kovacsova@tudelft.nl); a.l.schwab@tudelft.nl)

Intelligent Vehicles & Cognitive Robotics, Delft University of Technology, Delft, Netherlands

#### **ABSTRACT**

Research indicates that crashes between cyclists and car drivers often occur even when the cyclist must have seen the approaching car, suggesting the importance of expectancy and attention allocation issues [1]. To investigate where cyclists look when approaching an intersection with approaching car(s), 37 participants (mean age = 21.0 years; SD age = 1.4 years) viewed animated video clips of uncontrolled four-way intersections from a cyclist's viewpoint. Participants' eyes were recorded using the EyeLink 1000 Plus, and analysed with dynamic areas of interests (AOIs) defined around the road ahead as well as cars that approached the intersection from the right and left. Independent variables of the fixed animations were (1) approaching cars' deceleration, creating one unsafe and three safe outcomes (a. collision with a car coming from the right, b. cyclist passing in front of a car coming from the right, c. cyclist passing behind a car coming from the right, and d. cyclist passing in front of both a car from the right and left), and (2) fixed cyclist approach speed (a. 15 km/h, b. 25 km/h, c. 35 km/h). Each participant encountered each of the 12 conditions (4 car approach conditions \* 3 cycling speeds) three times. Visual behaviour was operationalized as the total net dwell time percentage (DTP), defined as the composite percentage of all participants' gaze samples within each AOI taken across the sum time of AOI visibility per each condition. A high DTP on the right car was found in the collision scenario as compared to the three safe scenarios. While both the road ahead and intersecting cars were available as candidates for participant gaze, a particularly high DTP was found for the colliding right car, whereas in the safe scenarios participants were more likely to gaze back to the road ahead. No substantial differences between the three cycling speeds were found regarding DTPs on the approaching



car(s). Overall, our results suggest that visual behaviour of cyclists approaching uncontrolled intersections differ between situational aspects of collision/non-collision outcomes and location of cars at the intersection. In conclusion, because different approach speeds have direct consequences for aspects of salient looming of the cars as visual targets but this did not strongly obtain in our measured visual behaviour, it might be generalizable that cyclists draw their visual focus more along lines of perceived hazards and intent (i.e., objects with future collision trajectory potential and priority).

**keywords:** expectancy, attention, visual behaviour

### ***Safety analysis of bicycle crossings in roundabouts***

Author(s): Aya Al-Ammari, Dr. Attila Borsos

Presenter: Aya Al-Ammari (borsosa@sze.hu)

*Department of Civil, Construction and Environmental Engineering, Sapienza University of Rome, Rome, Italy*

#### **ABSTRACT**

According to the current Hungarian priority rules for bicycle crossings at roundabout legs vehicles entering or exiting the roundabout should yield to pedestrians, however, bicycles should yield to both traffic streams. The aim of this research was to analyze the behavior of cyclists and drivers in bicycle crossings in roundabouts. This analysis was made at locations in the city of Győr (six sites, eight legs) fulfilling certain requirements. Three layouts were analyzed: one way and two way bicycle crossings with pedestrian crossing; and two way bicycle crossing without pedestrian crossing. Videos were recorded in the morning and afternoon peak hours. Road users' behavior were evaluated based on the interactions between bicycles (cyclist crosses without looking around, cyclist looks around but does not stop, cyclist looks around and stops) and vehicles (there is no vehicle, there is a vehicle not stopping, there is a vehicle stopping). These interactions served as a basis for the conflict analysis where four types were defined: potential, light, serious, and no conflict. Irregular and unexpected movements were also observed and traffic volumes (exiting, entering, circulating) counted. The overall finding was that drivers showed courtesy to bicyclists in spite of the priority rules. In terms of the share of conflicts the two way bicycle crossing without pedestrian crossing showed different results with a slightly bigger share of no conflict situations.

**keywords:** roundabout, bicycle crossing, conflict analysis

## DAY 2

### S7: INFRASTRUCTURE

#### ***Accident Risks Depending on General Cycle Path Design***

Author(s): Heiko Johannsen, Michael Jänsch

Presenter: Heiko Johannsen (Johannsen.Heiko@MH-Hannover.de)

*Accident Research Unit, Medizinische Hochschule Hannover, Hannover, Germany*

#### **ABSTRACT**

Two way cycle lanes are common in Germany especially in rural areas. However, sometimes they are also used within city limits. There are special accident risks connected with two way cycle paths. These are in towns at crossings where especially the drivers of motorised vehicles often do not consider cyclists using the left side cycle path and in rural areas at points where the cyclists need to cross the main road in order to get to the cycle path. For the study GIDAS (German In Depths Accident Study) which is based on a representative accident sample that is collected in Dresden and the surrounding areas as well as in Hannover and the surrounding areas. For this study it is important to know that in Hannover cycle paths within the town of Hannover are considerably often designed as two way cycle paths while it is not the case in Dresden. Within the GIDAS sample there are about 1,500 cyclists that were involved in an accident using the left cycle path within city limits and about 50 outside city limits. Both groups are almost similar in size compared to the cyclists that are using the cycle path on the right side. The paper analyses accident risks for cyclists using the left cycle path compared to those using the right one. There is also a comparison between those that are correctly using the left cycle path compared to the cyclists using it incorrectly. The analysis is conducted also by comparing the Dresden data to the Hannover data in order to analyse whether or not there are differences for the two cities with different cycle path design policies. In the scope of this study scenarios were created for conflicts of vehicles with cyclists at junctions in towns, while accidents in rural areas where the cyclists need to cross the main road could not be identified efficiently enough from the database. In general for the accidents at junctions in towns the analysis revealed that accidents with cyclists travelling on the left bicycle path (allowed or not) are not prone to a higher accident risk where a road user turns off the main road. There is however a higher risk at junctions where a road user crosses the bicycle path to enter the priority road which is influenced by the observation strategy of the entering vehicle. The comparison of the accidents situation of the cities Dresden and Hannover also revealed that seemingly there is no “training effect” in Hannover meaning that the road users there are more used to bicyclists on the left cycle path.

**keywords:** cycle path design, accident risk, accident causation

#### ***Bicyclist perceived level of traffic stress: a quality of service measure***

Author(s): Charlene Mingus, Aditi Misra, Timothy Welch, Kari Watkins

Presenter: Charlene Mingus, Aditi Misra (amisra7@gatech.edu)

*School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, United States*

#### **ABSTRACT**

To plan for expansion of the bicycle network, it is important for cities to know how existing facilities are performing and develop measures of performance. These bicycle quality of service measures often require data which are not readily available and which can only be obtained through extensive and costly field research. In addition, quality of service measures for the bicycle network are typically based on a level of service rather than a level of bicyclist comfort on the facility. The Level of Traffic Stress (LTS) measure developed for Mineta Transportation Institute was designed to fill this need, however, the proposed MTI LTS

leaves some gaps in its framework for designation of facilities. The enhanced LTS measure proposed here is based on traffic, roadway, and bikeway characteristics data available to most planning and engineering agencies in the United States and the classification of facilities is based on evidence from the literature. The enhanced LTS was used in a case study wherein roadway and bikeway facilities within a six-mile buffer zone of the Atlanta BeltLine Eastside Trail were classified and analyzed for LTS based connectivity. The analysis was done in ArcGIS and provides results that can be easily interpreted by the public and decision makers, while relying on quantifiable traffic and roadway characteristics. The proposed measure was also found to be useful in determining the perceived stress of different roadway and bikeway facilities for current and potential bicyclists.

**keywords:** Level of traffic stress, Quality of service, Bicycle network

### ***Safe cycling infrastructure: CycleRAP road assessment tool. Validation and implementation of the instrument***

Author(s): Gert Jan Wijlhuizen, Roxy S. Tacq, Jan Hendrik van Petegem, Erik de Kievit

Presenter: Gert Jan Wijlhuizen (gert.jan.wijlhuizen@SWOV.nl)

SWOV Institute for Road Safety Research, The Hague, The Netherlands

#### **ABSTRACT**

Yearly about 2000 bicyclist are killed in Europe. Only in The Netherlands, annually 10.000 bicyclists are seriously injured in traffic. Infrastructure is involved in about more than 50% of these accidents. In 2013, the ANWB in cooperation with SWOV initiated a project to develop and validate a tool for road managers to assess and improve the safety of the cycling infrastructure: CycleRAP. With this tool the ANWB promotes a proactive approach for cycling safety. A first version of the tool was developed in 2014, and in 2015 SWOV a validation study was performed in Amsterdam. In Amsterdam 250 kilometer of cycling infrastructure was assessed with CycleRAP. We included 212 streets in the analysis. Data were available on: cycling accidents from ambulance registration, daily flow of cyclists and motor vehicles, street length, CycleRAP data scores on quality, alignment and obstacles of cycling infrastructure. We applied negative binomial regression analysis to find relationship between cycling safety and infrastructure. The CycleRAP scores and average daily flow of cyclists and motor vehicles were significantly related to cycling safety (number of cycling accidents per unit of street length). CycleRAP seems to be a valid tool for assessing the safety of cycling infrastructure. There is a sound basis for the ANWB to make the CycleRAP method available to all national and international road managers as part of the EuroRAP/iRAP system.

**keywords:** Cycling Infrastructure, Cycling safety, Road assessment

### ***From data to practice: a cycling path review to assess the impact of urban mobility measures on cyclists***

Author(s): Arianna Bichicchi, Valeria Vignali, Andrea Simone, Claudio Lantieri, Marco Amadori

Presenter: Arianna Bichicchi (arianna.bichicchi2@unibo.it)

Department of Civil, Chemical, Environmental, and Materials Engineering, Alma Mater Studiorum University of Bologna, Bologna, Italy

#### **ABSTRACT**

This study presents a methodology to assess the safety of infrastructure systems. Observation data show that frequently cyclists prefer to use non-cycling paths discarding exclusive bike lanes, compromising safety. Two cycling paths were chosen from GPS data collected in 2015 in Bologna area. Firstly, a checklist was outlined to assess the cycling infrastructure and to observe the presence of deficiencies. In this way, an

accurate Bike-lane Safety Review is achieved. Then, on-site surveys on the paths enabled to analyze cyclists looking behaviour with an eye tracker tool and to notice their perception through interview. A crosscheck between checklists data and self-assessment interview highlighted an evident lack of signaling on bike lanes. A high percentage of cyclists pointed out that unsafe crossings are the most relevant problem, even if in the nearly totality the choice of the path depends only on travel time. Consequently, rational infrastructural improvements revealed to be necessary. The checklist is able to help local administrations in the management of cycling infrastructures through the identification of issues in order to guarantee comfort, safety and performance. The consequence is a benefit on infrastructures' attractiveness and encouragement of sustainable mobility. A benefit is the virtuous cycle created, where active citizens, through the activity of expertise from local authorities, are final beneficiaries of a safer mobility.

**keywords:** Safety review, Bicycle Paths, Eye tracking, GPS tracking

### ***Improving safety at intersection with designated bicycle paths – results of a conflict analysis***

Author(s): Emese Makó

Presenter: Emese Makó (makoe@sze.hu)

*Department of Transport Infrastructure, Széchenyi István University, Győr, Hungary*

#### **ABSTRACT**

At urban intersections, conflicts between turning vehicles and through non-motorized vehicles are a critical safety issue. According to one of our former results the biggest share of accidents belongs to movements, when turning vehicles do not yield to cyclists moving straight ahead on their designated bicycle path. In the recent research we have continued to analyse accident data specifically in the above presented traffic situation. The cities of Győr and Szombathely were chosen as study areas. In alignment with the former research the statistics proved similar results: 15% of all bicycle related accidents happened at intersections with designated bicycle paths. In order to recognise the cause of the accidents field surveys were conducted at the 12 most risky intersections. The average hourly conflict rate has been determined for each intersection. The results show that the average hourly conflict rate ranges between 36 and 50%. Typical causes of the conflicts were drivers not giving priority to cyclists and negligence of drivers when bicyclists are in dead angle. The findings of this study contribute to develop traffic countermeasures to improve cyclist's safety at intersection equipped with designated bicycle paths. This study demonstrates examples of safety measures for each selected intersections. However more studies at similar locations would be useful to develop guidelines for redesigning the existing crossing facilities.

**keywords:** intersection, conflict, turning

## S8: CYCLISTS BEHAVIOURS AND RESPONSES

### ***Understanding the cues and characteristics that indicate and affect a cyclist's future path: A focus group study conducted in the UK and Netherlands***

Author(s): D. R. Large, C. Harvey, G. Burnett, S. de Hair-Buijssen

Presenter: David R Large (david.r.large@nottingham.ac.uk)

University of Nottingham, University Park, Nottingham, United Kingdom

#### ABSTRACT

Cyclists must perform continuous threat assessment when choosing the safest path through the road environment. However, different situational interpretations exist among cyclists and other road users (e.g. car drivers) regarding risk perception and the responsibilities and liabilities of each party towards mutual awareness. Automated in-car, hazard-detection technology has potential to mitigate the risk to cyclists by warning drivers or taking control of their vehicle if a collision is imminent. However, the success of such technology is predicated on its ability to make an appropriate assessment of the behaviour of cyclists and accurately predict their future trajectory, in all situations. Six focus groups involving 24 cyclists and 13 car drivers were conducted in the UK and Netherlands, with different stakeholders assembled separately. The focus groups aimed to uncover the cues that indicate a cyclist's future path and the characteristics of the environment that may affect their choice, from both perspectives. Twenty-seven cues and twenty-five characteristics were identified and categorised into 4 themes: cyclists' appearance, communications and signalling, movement and position of bicycle, and environment and conditions. Results indicated consistency between groups, but were tempered by a cultural perspective, reflecting the higher social status afforded to cyclists in the Netherlands. The findings can be used to develop classification and coding schemes for naturalistic observations and to inform the development and evaluation of in-car cyclist detection and avoidance technology.

**keywords:** cyclist, driver, cues, characteristics, future path, focus group, UK, Netherlands

### ***The impact of environmental factors on cycling speed on shared paths***

Author(s): Soufiane Boufous, Julie Hatfield, Raphael Grzebieta

Presenter: Soufiane Boufous (soufiane@unsw.edu.au)

Transport and Road Safety, University of New South Wales, Sydney, Australia

#### ABSTRACT

Despite the importance of cycling speed on shared paths to the amenity and safety of users, few studies have systematically measured it, nor examined circumstances surrounding it. Speed was measured for 5421 riders who were observed cycling on shared paths across 12 metropolitan and regional locations in Sydney, Australia. Multivariate regression analysis was carried out to examine rider and environmental factors that contribute to riders cycling above the median speed. The study found that observed riders travelled at a median speed of 16 km/h (mean 18.4 km/h). Nearly 80% of riders travelled at 20 km/h or less and 7.8% at speeds of more than 30 km/h. Multivariate regression analysis indicated that riders were significantly less likely to cycle above the median speed on shared paths with an average volume of over 20 pedestrians/hour. Riders were significantly more likely to travel above the median speed on paths with a centreline (OR: 1.71, 95% CI: 1.41-2.07), on wider paths (over 3.5 m) compared to narrower paths (OR: 1.34, 95% CI: 1.12-1.59) and on paths with visual segregation between cyclists and pedestrians. Visual segregation was the strongest predictor of cycling travelling above median speed on shared paths (OR: 3.9, 95% CI: 3.1-4.8). The findings suggest that riders adjust their speeds according to shared path conditions and to accommodate pedestrians and highlight the importance of shared path design to the safety of users.

**keywords:** shared path, cycling, speed

***Investigation of cyclist responses to a two-stage right-turn facility***

Author(s): George F. Beard

Presenter: George F. Beard (gbeard@trl.co.uk)

*Transport Research Laboratory, Wokingham, United Kingdom*

**ABSTRACT**

A series of controlled off-street trials examined a novel design of ‘Standardised Junction’. The design included 4 junction arms, with a cycle reservoir on each approach, low-level cycle signals (LLCS), and a two-stage right-turn (2SRT). The study investigated how cyclists turned right in response to the signage, road markings and traffic signals in this facility. Contracted drivers were employed to simulate moderate traffic conditions during the trial. When approaching red signals, cyclists chose to stop in the cycle reservoir about 90% of the time. About 95% of the time, cyclists responded correctly to LLCS. The rate of utilisation of the 2SRT was about 25%; most of the time (75%) cyclists performed a ‘standard’ right-turn. When cyclists approached on green signals (and were unable to merge with traffic due to trial safety restrictions), the majority (66%) preferred to use the 2SRT. This was supported by questionnaire responses about how cyclists would behave in the ‘real-world’. There was some evidence of a learning effect; increased experience with the facility may have led some cyclists to adjust their behaviour on subsequent attempts. Subjective ratings related to the ease of completing a right-turn and perceived safety when doing so were generally high.

These findings informed the roll-out of new cyclist infrastructure at various locations in London as part of the ‘Cycle Superhighways’ scheme.

**keywords:** Two-stage right-turn, Cyclist behaviour, Cyclist safety



## S9: CYCLISTS BEHAVIOURS AND ATTITUDES

### ***Safety-Oriented Bicycling Practices and Traffic Accident Involvement***

Author(s): Mark W. Hoglund

Presenter: Mark W. Hoglund (mark.hoglund@downstate.edu)

*Suny Medical Center, Department of Family Medicine, New York City, USA*

#### **ABSTRACT**

Many U.S. bicyclists are killed or injured in traffic accidents annually. Based on analysis of available research and published reports on traffic accidents, it was theorized that adherence to six safety-oriented on-road bicycling practices will reduce involvement in traffic accidents. This study investigated whether adherence to the six safety-oriented bicycling practices is associated with reduced involvement in traffic accidents. U.S. bicycle riders responded to an anonymous on-line survey covering bicycling practices, recent accident experiences, and potential confounders. Participants were recruited via on-line announcements to bicycling-related organizations. After adjustment, reduced traffic accident involvement was predicted by riding at a speed that feels safe and avoiding passing motor vehicles in moving traffic. Obeying traffic signals and avoiding entering the roadway from a blind spot were protective only for riders who reported use of certain electronic devices. Reduced accident involvement was not found to be associated with vigilance or yielding right-of-way. The results demonstrated the value of investigating how on-road bicycling practices can reduce traffic accident involvement. The results provided limited support for the specific theoretical construct; however, individual survey items may have been insufficiently sensitive to be useful measures. Alternative approaches may prove more effective.

**keywords:** Bicycling practices, Traffic accidents, Prevention

### ***Smartphone Specific Violations and Near Crashes among Italian Cyclists***

Author(s): Víctor Marín Puchades, Luca Pietrantonio, Federico Fraboni, Marco De Angelis, and Gabriele Prati

Presenter: Víctor Marín Puchades (victor.marinpuchade2@unibo.it)

*Department of Psychology, Alma Mater Studiorum University of Bologna, Bologna, Italy*

#### **ABSTRACT**

High percentages of cyclists admit using smartphone devices while cycling. Moreover, such use has been found to be associated to near crashes and crashes, representing a risk factor for cyclists. This study examines the relationship between such type of behaviors, comprising, both calling and manipulating the screen, and the frequency of near crashes and actual crashes among Italian cyclists. We administered an online survey measuring smartphone specific violations, errors, near crash and crash to Italian cyclists (N=264; age range: 19 – 82). We hypothesized that the relationship between smartphone use and near crashes would be explained by an increase in the number of errors committed, thus increasing the likelihood of being involved in near crashes. Moreover, we hypothesized that near crashes will predict actual crashes. Results of path analysis showed that smartphone-specific violations predicted crashes throughout their consecutive effects on errors and near crashes. These findings offer an explanation of how smartphone use contributes to increment the likelihood of getting involved in near crashes and actual crashes. To our knowledge, the present study is the first in building a path model explaining how smartphone specific violations lead to more near crashes among cyclists.

**keywords:** Smartphone Specific Violations, Errors, Near Crashes

### **Urban cycle path users: numbers, characteristics, behaviour and conflicts**

Author(s): Jolieke de Groot, Kirsten Duivenvoorden, and Luuk Vissers

Presenter: Jolieke de Groot (jolieke.de.groot@swov.nl)

Road Safety Assessment, SWOV Institute for Road Safety Research, The Hague, The Netherlands

#### **ABSTRACT**

In the Netherlands, especially in big cities, bicycle mobility is increasing; not in the least because of stimulating policy measures by the municipalities. However, cyclists are also vulnerable road users. Cyclists' vulnerability in combination with their increased mobility has caused some concern about crowded cycle paths. Especially the mingling of cyclists with light mopeds is associated with nuisance and perceived risk. In this study, the central question of this research is whether increased traffic intensity implies increased variety of users and speeds, and if so, whether this is associated with increased risk. To answer this question, numbers and characteristics of bicycle path users were investigated. Cameras were placed on eight cycle path locations in two Dutch cities. In total 9 days of footage (morning rush hour) was used for analyses. Data concerning numbers and types of users, their speed, their behaviour and possible conflicts were analysed. Results indicate that over 90% of cycle path users are standard cyclists and 6% are light moped riders. Taking into account the design guidelines for bicycle paths, four out of eight cycle paths can be considered crowded. This means that the width is too narrow given the numbers of users (mostly cyclists). One out of five cyclists or moped riders is handling their phone while riding and four out of five do not look over the shoulder when overtaking. Up till one out of twenty cyclists rides in the wrong direction on the cycle path. Only a few conflicts were observed in this study. Especially when it is crowded, aberrant behaviour may cause nuisance, annoyance and even increased risk. Therefore the behaviour of cyclists and light moped riders requires attention, especially their mobile phone use.

**keywords:** Cyclists, light mopeds, cycle paths, distraction

### **A longitudinal study of risk compensation from bicycle helmets with an app-based data collection**

Author(s): Christian Weber, Hanne Beate Sundfør, Aslak Fyhri

Presenter: Aslak Fyhri (af@toi.no)

Department of Safety, Security and Environment - Research Area Environment and Climate, Institute of Transport Economics, Norwegian Centre for Transport Research, Oslo, Norway

#### **ABSTRACT**

Bicycle helmets have been subject to much debate. One important topic for discussion is the degree of risk compensation associated with their use. Previous studies have showed that participants who are given no time, or a short time (two hours) to get accustomed to the helmet do not increase their speed when wearing one. Studies where participants wear a helmet for several weeks to test the long term speed change effects are called for. The current study is a longitudinal field experiment of risk compensation from helmets. Non-routine helmet users are recruited in the field (N=40). Half are randomly selected to the test group and half are selected to a control group. The participants in both groups are instructed to download an application (Blue.TOI) which automatically detects a bicycle trip and logs speed (+/1 kmh) and GPS coordinates. The study consists of a pre-trial period where none of the users wear a helmet, and a trial period where the test group are instructed to wear a helmet for all trips. The control group are not given any instructions. The trial period lasts for three weeks. We compare average changes in speed from pre-trial to trial period between users and non-users. Further, we test for a time effect. Data will be collected in August 2016, and results are presented at the conference. The research design with the precise and objective data from the app, makes it possible to draw quite strong conclusions about the risk compensation effects of the helmet. Possibilities for other behaviour measurements (accelerometer/gyro data) are discussed.

**keywords:** Bicycle helmet, Mobile application, Risk compensation

## S10: CYCLISTS INJURY PREVENTION

### ***Preventing Shoulder Injuries in Bicycle Crashes***

Author(s): Helena Stigson, M. Fahlstedt, M. Y. Svensson

Presenter: Helena Stigson (helena.stigson@folksam.se)

*Department of Applied Mechanics, Chalmers University of Technology, Göteborg, Sweden*

#### **ABSTRACT**

Cyclist injuries leading to long-term consequences are common and therefore important to address in order to design a more sustainable road transport system. Previous research shows that of all impairing injuries, almost 50% were to the upper extremities. The most common in-juries to the upper extremities leading to medical impairment were to the shoulder and the wrist. In 90% of the cases the injury to the shoulder resulted from a fall onto the shoulder. Shoulder pads could be a possible solution to reduce the number and severity of the injuries. The aim of the present work was to investigate the potential effectiveness of shoulder protection. To validate the possible effectiveness of shoulder pads a comparison between the responses of a finite element model (THUMS) with and without shoulder pad was made. A fall from 1.3 m with a shoulder impact was simulated. To evaluate the effect of an existing shoulder pad aimed for downhill cycling a crash test with a crash test dummy (WorldSID) was conducted. The WorldSID was impacted in three different set ups: with, without shoulder pad and with a prototype shoulder airbag. The simulations showed that the maximum stress (von Mises) in the clavicle was reduced by 7% when a shoulder pad was used (138 MPa without and 129 MPa with pad). The crash tests show that the shoulder airbag compared to shoulder pad was more effective in reducing the impact force. This reduction in force corresponds to a seven times lower shoulder injury risk. Results show that a protective device for the shoulder has the potential to reduce risk of shoulder injuries.

**keywords:** bicycles, shoulder injury, long-term consequences, protective gear, shoulder pad

### ***Experimental and numerical considerations of helmet evaluation under tangential impact***

Author(s): Nicolas Bourdet, Peter Halldin, Caroline Deck, Remy Willinger

Presenter: Jey Nadarasa (jey.nadarasa@gmail.com)

*Institute of Mechanics of fluids and solids, Unistra Strasbourg University, Strasbourg, France*

#### **ABSTRACT**

Based on real world bicycle accident reconstructions and virtual accident simulations, the present study proposes realistic head impact conditions in terms of tangential impact velocities (6.5 m/s ; 45Å). Thus, an existing bicycle helmet has been impacted frontally and laterally under tangential impacts with a Hybrid III dummy head fully instrumented for a 6D motion recording. The head acceleration curves were implemented in the Strasbourg University FE Head Model in order to assess the brain injury risk in terms of axon strain. Results of the experimental respectively numerical head response are expressed in terms of maximum linear plus rotational accelerations and HIC, respectively percentage of DAI risk computed with the numerical head model. Results show maximum linear acceleration of about 152g leading to HIC of 700. The maximum rotational head accelerations ranged from 5 to 12 krad/sÇ, according to the rotation axis. The numerical head injury risk assessment conducted to a risk of moderate DAI in the 70% to 100% range. It is demonstrated that helmet improvement is encouraged as protection solution should include the management not only of the maximum linear or rotational accelerations but also the direction and time evolution of these parameters via the use of model based head injury criteria. This study is therefore a demonstrator for novel helmet test method as well as a step for advanced bicycle helmet design.

**keywords:** Bicycle helmet, Bicyclist's head impact conditions, Helmet test method, Model based head injury criteria

### ***Accident Situation of Pedelecs and comparison to conventional Bicycles***

Author(s): D. Otte, T. Facius

Presenter: Dietamr Otte (otte.dietmar@mh-hannover.de)

*Accident Research Unit, Hannover Medical School, Hannover, Germany*

#### **ABSTRACT**

This Study is dealing with the accident situation (accident type, collision partner, collision speed two-wheeler and collision partner, demographic data of the riders, use of cycle lanes, use and protective effect of helmets, injury severity and injury patterns of the riders) of motor-assisted pedal cycles (pedelecs / e-Bikes), especially the comparison to the accident situation of conventional two-wheeler is described. Therefore, the accident data of 64 injured drivers of motor-assisted pedal cycles, involved in an accident, was analysed and compared to 3,608 bicyclists, involved in an accident. The data from the years 2009 until 2015 collected by a scientific research team at the Hannover Medical School for the GIDAS project (German In-Depth Accident Study) was used as study sample. It was shown that injuries did not occur more often or more serious in pedelec accidents than in standard cycles. In this study mainly pedelec drivers with MAIS 1 and MAIS 2 (slight and moderate injured) were documented and only one case with severe injuries (MAIS 3), whereas there was injury severity MAIS 3+ with 4.3 % documented on conventional bicyclist. The statistical analysis (statistical significance) showed that head injuries occur more often in pedelecs drivers with 42.2% compared to 35.7% in conventional bicyclists. Furthermore, there are more driving accidents with 21.8% in pedelecs accidents, this means single-vehicle accidents like falls or collisions against objects, in comparison to 12.0% in bicycle accidents. Additionally, the pedelec-drivers are much older than the bicyclists and the injury pattern of bicyclist and pedelec riders seem to be dependent on the age of the rider. With increasing age a rising risk of head injuries appears and therefore also an important injury prevention through the use of bicycle helmets.

**keywords:** accident situation, Electric bicycle, e-bike, pedelec, injuries, injury severity, injury pattern, helmet effectiveness

### ***Assessing performance of bicycle helmets***

Author(s): Anna M. MacAlister, David S. Zuby, Megan Bland, Steven Rowson, Stefan M. Duma

Presenter: David S. Zuby (dzuby@iihs.org)

*Insurance Institute for Highway Safety, Arlington, VA, United States*

#### **ABSTRACT**

Bicycle-related head injury is a major source of cyclist fatality. Although helmet usage has been shown to help prevent cyclist injury and death, studies vary significantly in their reports of helmet effectiveness. Some of this variation may be attributed to differences in helmet performance. A twin-wire drop rig and flat anvil were used to test ten helmet models in the U.S. Consumer Products Safety Commission (CPSC) configuration. Four samples per helmet were tested in four impact configurations: two velocities (3.4 m/s, a common impact velocity in real crashes, and 6.2 m/s, as in the CPSC standard) combined with two mirrored helmet locations (frontal at the rim and temporal above the CPSC test line). Peak linear accelerations were used to determine risk of skull fracture and concussion for each impact. Performance varied considerably between helmet models and impact configurations. Concussion risk was low (3-18%) at the frontal location but varied more at the temporal location, with four helmets having over 67% risk. Skull fracture risk was generally low, but two helmets exceeded 50% risk at the frontal location. Because the frontal location is at the rim and below the CPSC test line, helmets are not tested here during the certification process, and impact performance at this location is unregulated. Significant performance differences exist in modern bicycle helmets. Helmets that meet the CPSC standard may not protect cyclists equally well.

**keywords:** Bike helmet, Head injury

### ***Safety performance testing of helmet-mounted cameras***

Author(s): Philip S. Martin, Vincent J. StClair, Claire Willis, Alastair C. Rickman, and David Hynd

Presenter: Philip S. Martin (pmartin@trl.co.uk)

Transport Research Laboratory, Wokingham, United Kingdom

#### **ABSTRACT**

The study aimed to establish the potential effects of helmet-mounted cameras on injury risks associated with falling object strikes and falls onto flat and angled surfaces. European helmet test standards and regulations were adapted by three studies. Study 1 performed falling striker tests, Study 2 performed linear headform drop tests onto a flat anvil and Study 3 performed oblique headform drop tests onto an anvil angled 15° from vertical. Three helmet categories (hard-shell, foam & hybrid) were impacted at three locations (vertex, front & side), using five camera mounting combinations and three control helmets. Data was collected for headform forces, linear accelerations, rotational velocities and rotational accelerations. No increase in head injury risk was found for forces transferred to the head during falling object strikes or with linear accelerations experienced during falls onto flat and angled surfaces. Although increased rotational head velocities and accelerations were found with falls onto flat and angled surfaces, no injury threshold or legislative performance criteria was exceeded by any investigated helmet and camera combination. All helmet and camera combinations investigated by this project complied with current legislative performance criteria, while no combination exceeded published injury thresholds. Further research is required to investigate additional impact mechanisms, helmets and camera mounting configurations.

**keywords:** Helmet, Injury, Safety

### ***Bicycle helmets and head injuries — a case control study***

Author(s): Torkel Bjørnskau

Presenter: Torkel Bjørnskau (tbj@toi.no)

Transportøkonomisk institutt, Oslo, Norway

#### **ABSTRACT**

There has been a big debate in the research community about the injury-reducing effects of bicycle helmets. Most case-control studies document an effect, but often these studies have been criticised for lack of control for important confounders. According to the Traffic Safety Handbook there is a documented effect on head injuries, but if one combines head, neck and face injuries, correct for publication bias and include the most recent studies, there is no effect. These results are based on case-control studies, which have been criticised for not controlling sufficiently for possible confounders. The study reported here consists of injury data from bicycle accidents in Oslo, Norway in 2014. All bicyclists admitted to hospital treatment during 2014 (N=2138) were registered and interviewed about their trip, their bicycle, the accident location, type of injury, helmet use, speed etc. Injuries were registered according to standard injury classification (AIS). A crude case control estimation revealed strong effects of helmet wearing with odds ratios of .5 for all head injuries and .6 for serious head injuries. The effects remained strong and significant after controlling for possible confounders like experience, age, speed, alcohol. However, with serious head injuries as dependent variable, logistic regression models comprising all relevant confounders revealed a smaller effect not statistically significant by applying the conventional .05 level. The most important risk factor is alcohol consumption increasing the odds of serious head injury by a factor of 2.7. The study reveals that bicycle helmets reduce head injuries but that the effect is substantially reduced when controlling for relevant confounders. Alcohol consumption is a

particularly important confounder in this analysis and the omission of this variable in previous studies may have given bicycle helmets a too advantageous effect in previous research. Methodological issues and possible implications are discussed.

**keywords:** bicycle helmets, injury-reducing effect, case-control study

***Out of the darkness - a survey of bicycle rear lighting in a typical North American city***

Author(s): Christopher B. Morris

Presenter: Christopher B. Morris (cminkey@telus.net)

*Pedal Depot Bike cooperative, Vancouver, Canada*

**ABSTRACT**

There is a tendency in North America, even in bicycle-friendly cities such as Vancouver, to treat bicycles as toys for leisure activity. One of the unfortunate effects of this is that standards for such key safety issues as braking or lighting are often inadequate, and even those standards are then inadequately enforced. By comparison, Europe has a well-structured series of regulations that define the standard and ensure new bicycles are sold that comply. Enforcement is also taken seriously in Europe, and consumers are educated to see the advantages of this rigorous approach. The paper focuses on one particular (though vital) issue, being seen after dark from the blind (rear) side. In other words, an adequate rear light for the bicycle. Using Vancouver as a typical example, current practice is investigated, and the technology choices available discussed. Comparisons to the European standards and practice are drawn where possible. This paper is part-review of the modern choices for rear lighting (their advantages and disadvantages), and part-survey of actual current practice using a well-known bike route in Vancouver, as a survey base after dark. The local authorities are contacted for information on enforcement of existing lighting laws. Results are still in progress. Based on the survey findings and the standards framework, recommendations are made to improve North American bicycle rear lighting safety, both in terms of best practice as well as improved standards and enforcement (from dealer to consumer). The objective is to lower the accident rate in a typical North American city after dark by encouraging use of a simple device (a well-designed rear lamp, universally fitted), with much lower investment implications than almost any other safety device or bikeway re-design). It is time for a change in attitude on this continent as the bicycle becomes an 'A to B' method of daily urban transportation rather than a leisure toy.

**keywords:** North America, rear lighting, current practice



## S11: INTERACTION BETWEEN CYCLISTS AND HGVs/BUSES

### ***Risk Factors in Bicycle-Truck Interactions***

Author(s): Petr Pokorny, Kelly Pitera

Presenter: Petr Pokorny (petr.pokorny@ntnu.no)

Faculty of Engineering Science and Technology, Norwegian University of Science and Technology, Trondheim, Norway

#### ABSTRACT

Given the complexity of the road transportation system and safety issues associated with it, it is suitable to combine multiple methods in order to identify and study the risk factors inherent in different levels of the system. This project aims to do such while addressing the issue of bicycle-truck encounters in Norwegian urban areas. As these encounters are an understudied area, both identification of risk factors and evaluation of methods used were of interest. Several methods, as listed below, were applied:

- Statistical analysis of accident data and review of in-depth fatal accidents' reports
- Online survey and interviews with cyclists, truck drivers and companies' managers
- Behavioural analysis using long-term camera recordings

Accident data were reviewed to improve their quality and additional information was gained from in-depth analysis of fatal accidents. Reduced visibility related to both blind spots and visibility obstructions was found to be one of the most critical risk factor. It has connections to infrastructure layout, weather conditions, truck types and behavioural aspects. Wet road surface was found as significant variable influencing the seriousness of accident consequences. Females were overrepresented in truck-bicycle accidents compared to other bicycle accidents. The variability of accident types was significantly diverse in selected cities, suggesting an influence of different infrastructure layouts prominent in each city. Surveys of cyclists found large amount of conflicts experienced with trucks. Those connected with blind spots were the most frequent. Again, the variability of conflict types was significantly diverse in selected cities. Interviews with truck drivers and managers from truck's companies showed variability in routes planning practises and in company safety culture, which are influenced by the size and type of the company. In order to evaluate the influence of infrastructure layout on bicycle-truck encounters, long-term recordings of selected sites in Trondheim (Norway) have been conducted and behavioural analysis will be carried out. Applying several specific methods to study one particular safety topic improved the identification of risk factors and reveal relationships that would otherwise stay hidden.

**keywords:** road safety evaluation, heavy vehicles, bicycles, urban areas

### ***Turning a corner in cyclist safety: an auditory alert to improve truck driver detection of cyclists***

Author(s): Daryl L. Hibberd, Oliver M. J. Carsten

Presenter: Daryl L. Hibberd (D.L.Hibberd@leeds.ac.uk)

Institute for Transport Studies, Univeristy of Leeds, Leeds, UK

#### ABSTRACT

Cyclists are disproportionately represented in the killed and seriously injured casualties of road accidents. A review of existing accident databases has identified collisions between cyclists and trucks, especially during truck turning manoeuvres, as a dangerous scenario for cyclists. The XCYCLE project will develop a novel in-vehicle technology to support driver situation awareness and aid in the detection of cyclist position and trajectory, so that these collisions can be avoided. The study will be conducted during the Summer. This paper discusses an upcoming study involving the presentation of directional sound alerts designed to help drivers detect a cyclist in their blind-spot. A series of auditory stimuli including pure tones, auditory icons e.g. a bicycle bell, and speech will be presented to participants in a sound-attenuated booth using a surround

sound set-up. Stimulus characteristics such as frequency, amplitude and duration will be manipulated. Participants will rate perceived urgency, perceived direction, perceived meaning and perceived annoyance of the alert. Localisation accuracy and reaction time will be recorded. These ratings can be combined to identify the most psychologically appropriate auditory warning to direct driver attention to cyclists in the immediate vicinity of the vehicle. This study represents the first step in a user-centred design process. The results of this work will inform the design of a multi-modal HMI to be tested more extensively in a high-fidelity truck simulator. The objective is to design an effective, understandable and user-friendly interface for the detection of cyclists.

**keywords:** HMI, auditory warning, accident avoidance

### ***Requirements and Test Procedure for a Driver Assistance System for Right-Turning Trucks***

Author(s): Patrick Seiniger, Benjamin Schreck, Oliver Bartels and Jost Gail

Presenter: Patrick Seiniger (seiniger@bast.de)

*Federal Highway Research Institute (BASt), Bergisch Gladbach, Germany*

#### **ABSTRACT**

Turning manoeuvres with collisions between trucks turning right and cyclists usually have serious consequences for the vulnerable road user. Since driver assistance systems are state-of-the-art in a lot of vehicle segments, it seems to be beneficial to use such systems to address turning accidents between trucks and cyclists. BASt did analyse accident databases to identify relevant parameters during the conflict between one truck and one bicycle. Based on these parameters, simulations were carried out to define the necessary sensor field of view and implications from driving dynamics. Test cases were defined and verified using custom and commercially available test tools. Accidentology shows that the relevant accidents involve a truck and a bicycle first travelling in parallel at speeds up to 20 km/h, then the truck turning towards the bicycle path. It is anticipated that at this stage only information-providing assistance systems are promising. Corresponding test scenarios have been defined and verified: test results of a prototype assistance system in the scenarios as well as an overview of the successfully used test tools will be given. Intermediate results from this research project have been introduced into the rulemaking process in the UN ECE which will be the base for a possible future UN regulation for a blind spot driver assistance system for trucks to avoid blind spot accidents in the future.

**keywords:** Driver assistance systems, regulation, blind-spot accidents, trucks, bicycles

### ***Tackling the Danger of Blind Zone Collisions***

Author(s): Olga Slobodova

Presenter: Olga Slobodova (olga.s@safetyshieldsystems.com)

*Safety Shield Systems, European Office, Toulouse, France*

#### **ABSTRACT**

One third of cyclists' fatalities are caused by accidents involving buses and lorries. Indeed, bicycles are difficult to observe both at day and at night and often cannot be seen by the drivers of large vehicles due to the blind zone. After extensive work carried out with TfL and Ealing Council, we have developed Cycle Safety Shield, a collision avoidance system focused on the safety of the most vulnerable road users. It is especially designed to reduce driver's distractions, while eliminating the blind zones. As a result of the trials with TfL and Sainsbury's, the system alerts were recorded and analysed by individual bodies. The study showed that the systems helped to avoid almost 30 serious collisions in a period of 8 months. Further to the trials, we have developed a Data Capture Telematics System to answer the need of transport and city authorities for a

complete and reliable statistical data set, upon which they could make informed decisions on cycling infrastructure investments. Therefore, the system records all anti-collision alerts and their appropriate parameters. The next step is to obtain statistics from different urban environments in order to make a reliable analysis on the most common reasons of dangerous road situations involving vulnerable road users and, subsequently, on the most appropriate solutions.

**keywords:** Cycle safety, Blind zones, ITS

***Share the road: An experiential approach to achieving road behaviour change between cyclists and heavy vehicle drivers***

Author(s): R. Barter

Presenter: R. Barter (richard@can.org.nz)

*Cycling Action Network: Share the road Campaign, Auckland, New Zealand*

**ABSTRACT**

In New Zealand heavy vehicles are over represented in fatal crashes involving cyclists, in comparison with their proportion of the total vehicle fleet and vehicle kilometres travelled (Koorey, 2014). The goal of the Share←the→road Workshops is to improve the road user behaviour of heavy vehicle drivers and cyclists. NZ is starting to invest in cycling infrastructure, however the implementation of this will take time and therefore behavioural measures in the interim are important. Over the past five years, the monitoring of 2,300 participants and the analysis of workshop outcomes has resulted in a model based on exposure to the “on road experience of others” rather than a knowledge-based instructional approach. Preliminary evaluation of this approach has shown that individual cyclists retrospectively reported changing the way they cycle around heavy vehicles due to better knowledge of the blind zones. Heavy vehicle drivers report more respect towards cyclists and an understanding of why and where cyclists ride (Hawley, 2015). As improvements in knowledge or skills may not automatically translate into improved road user behaviour, (Christie, 2001; Twisk, 2013), this presentation will explore the mechanism by which cyclists and heavy vehicle drivers are being ‘motivated’ to behave safely in the vicinity of each other. The challenges in reaching target groups and long term plans for embedding this approach in driver and cycle skills training will also be discussed. To date the experiential learning workshop model has developed out of practice rather than desk based research. If it were possible the author’s wish would have been to enable this conference audience to sit in the driver’s seat of a heavy vehicle and to observe it’s on road dynamics from the saddle of a bicycle. The logistical difficulty of this highlights one of the models limitations.

**keywords:** Heavy Vehicles, Cyclists, Road Sharing, Experiential learning.

## S12: ACTIVE SAFETY SYSTEMS

### ***Interactions between cyclists and automated vehicles: results of a photo experiment***

Author(s): M.P. Hagenzieker, S. van der Kint, L. Vissers, I.N.L.G. van Schagen, J. de Bruin, P. van Gent & J.J.F. Commandeur

Presenter: Marjan Hagenzieker (marjan.hagenzieker@swov.nl)

Department of Transport and Planning, Delft University of Technology, Delft, Netherlands

#### ABSTRACT

In the near future non-motorized road users like cyclists and manually-driven vehicles will have to share the road environment with partly and fully automated vehicles. This upcoming interaction is challenging because traditional road users may not have correct expectations of the behaviour of automated vehicles, which brings extra risks in traffic. The objective of the present explorative study was to find out whether the expectations and behavioural intentions of cyclists when interacting with automated vehicles differ from those when interacting with a manually-driven car. A photo experiment was performed in which 29 participants judged different bicycle-car interactions from the perspective of the cyclist. The photos showed situations involving either an automated car or a manually-driven car. We also varied instructions to participants, and assessed whether a positively phrased description of automated driving induced different expectations than a more neutral phrased one. Participants were asked how sure they were being noticed by the car shown in the various situations, whether the car would stop for them, and how they would behave themselves. The findings generally point at a conservative, rather cautious disposition of the participants towards automated driven cars, in the sense that they were more sure to be noticed when interacting with a traditional, manually driven car than with the two 'automated' cars. The instruction describing a more positive picture of automated cars indicated to counteract this somewhat. Female participants preferred the sticker on the side of the car over the rooftop text as indicator of an automated driven car, while males preferred the text on the roof plate. These results are discussed and suggestions for future research are given.

**keywords:** cyclists, automated driving, autonomous vehicles, interaction, expectations, behaviour, external features

### ***Design and evaluation of a green wave safety system: technological and human factors aspects***

Author(s): Arjan Stuiver, Dick de Waard, Martine J. Wester, and Karel A. Brookhuis

Presenter: Arjan Stuiver (a.stuiver@rug.nl)

Faculty of Behavioural and Social Sciences, Clinical & Developmental Neuropsychology, University of Groningen, Groningen, Netherlands

#### ABSTRACT

Developments in technology to detect cyclists on cycle paths and advanced algorithms for traffic regulation installations enable optimisation of the traffic flow through a 'green wave' for cyclists. Delaying green time for cyclists until they arrive ensures that no additional red time for other traffic is introduced. Within the Horizon 2020 project XCycle these systems are developed and improved. In this paper the design and evaluation of a system to communicate the information of the green wave to the cyclists is described. Based on an expert review, a pilot test with naïve users and the results of a lab-experiment, a field setup and an evaluation plan for the setup was developed. From the expert review and naïve user pilot test, the most important characteristics were distilled. These were combined into a small number of pilot systems that were evaluated in a lab test. Recommendations from the results of the lab test were used to describe how to implement and evaluate the green wave system on the road.

**keywords:** cyclist, green wave, evaluation

### ***Intelligent and Safer Junctions, Supporting Safer Cycling***

Author(s): John McLaughlin, Steven Davy, Frances Cleary, David Ryan

Presenter: David Ryan (dryan@tssg.org)

TSSG, Waterford Institute of Technology, Waterford, Ireland

#### **ABSTRACT**

Vulnerable road users, in particular cyclists, are being overlooked as a target to benefit from advanced safety measures that take advantage of Intelligent Transportation Systems and the latest sensor technology. The Safer Cycling project delivers a validated solution that can have a meaningful impact on reducing fatalities and injuries involving cyclists occurring at roundabout junctions. It achieves this through a low cost, Bluetooth beacon technology based system that can be fitted to existing junctions. The paper presents the results of trials conducted in a close to live deployment, and illustrates that the accuracy of Bluetooth based positioning is accurate enough to track beacon tags on busy roundabout junctions. It was discovered during the course of the trials that by strategically positioning the beacon tags on the junctions we could accurately track the progress of the cyclist through the junction. We show that this tracking information can be used to improve the digital visibility of vulnerable road users to other motorists.

**keywords:** Bluetooth beacon, trilateration, GPS, road safety, reduced fatalities, roundabouts, traffic, zone transition, traffic alerting, junctions

### ***Increasing cyclist safety with infrastructural supported cooperative ADAS in EU XCYCLE by extending test site AIM Research Intersection – concept & status***

Author(s): Kay Gimm, Sascha Knake-Langhorst, Mandy Dotzauer, Uwe Urban

Presenter: Gimm or Knake-Langhorst (kay.gimm@dlr.de)

Institute of Transportation Systems, DLR, German Aerospace Center, Köln, Germany

#### **ABSTRACT**

In the context of the EU-funded project XCYCLE an infrastructural supported cooperative advanced driver assistance system (C-ADAS) will be built to increase safety of cyclists applying a cooperative, communicative approach. The given use case focuses on upcoming critical interactions between turning motorized vehicles (especially trucks) and cyclists. In case a critical encounter is predicted by the system, warnings are transmitted to the truck driver and the cyclist. For the given functionality, as a first step, it is necessary to detect and classify relevant traffic participants and predict the outcome of their interaction. In this paper, it is described how the infrastructure-based instrumentation in the test field AIM (Application Platform for Intelligent Mobility) in Braunschweig is setup. Within the framework of XCYCLE, the AIM Research Intersection is extended with a new infrastructurebased multi-sensor vehicle and vulnerable road user (VRU) detection system. An approach for situation and risk assessment using surrogate safety measures (SSM) such as time to collision (TTC) based on trajectory data is introduced. Approaches from the human factors perspective are taken into consideration examining driving behaviour of motorists and VRU and their interaction before and while turning in order to better predict conflicts. One of the key features of the cooperative approach lies in a systematic exchange of information between equipped traffic participants and infrastructure by using V2X communication to improve the performance of the assessment in comparison to a vehicle based stand-alone system.

**keywords:** bicycle crash prevention, cooperative ADAS, traffic conflict analysis, surrogate safety measures, situation assessment, application platform for intelligent mobility

## POSTER SESSION

### ***Cycling accidents in early adolescence: The role of executive functions in relation with risk-taking behaviour***

Author(s): Anika Fäsche, Andrea Ludwig, Stefanie Y. Schuler, Wiebke F. Evers

Presenter: Anika Fäsche (anika.faesche@uni-ulm.de)

Universität Freiburg im Breisgau, Freiburg im Breisgau, Germany

#### ABSTRACT

In Germany 10- to 14-year-olds experience more cycling accidents than any other age group. Previous studies suggest influence of puberty-related increase in risk-taking, while executive functions (EF) struggle to balance out due to immaturity at that age. The role of EF in cycling safety has not yet been investigated. The present study aims at testing direct and indirect relations between EF, risk-taking, occurrence and severity of cycling accidents in early adolescence. Participants were 1024 secondary school students between 10 and 15 years. Risk-taking was assessed with the JTCI (Goth & Schmeck, 2009), deficits in EF with the BRIEF (Drechsler & Steinhausen, 2013). Analyses controlled for i.a., knowledge of traffic regulations, cycling safety, susceptibility to peer influence, multilevel structure of data. Multiple latent path models showed positive direct relations only between deficits in EF and occurrence of accident. Analyses revealed however positive indirect relations for risk-taking via deficits in EF. Regarding severity of accident, results showed direct positive relations only with risk-taking, and positive indirect relations for deficits in EF via risk-taking. Deficits in EF put children at greater risk to experience cycling accidents. For occurrence of accidents EF act as a mediator, while for severity of accidents the effect of EF is mediated by students' risk-taking. Thus, training EF might reduce occurrence and severity of cycling accidents in early adolescence.

**keywords:** cycling accidents in early adolescence, executive functions, risk-taking behaviour

### ***Bike Crash Analysis: how considering party-at-fault and age of the bicyclist leads to better understanding of a town's crash profile and risk factors***

Author(s): Michelle M. DeRobertis, Carol R. Levine

Presenter: Michelle DeRobertis (m.derobertis@unibs.it)

UC Berkeley, Berkeley, United States

#### ABSTRACT

Analyzing collision history is important in selecting appropriate strategies to reduce crash risk. These can be infrastructure improvements, education, or enforcement. Automobile crashes in the United States are often analyzed by collision-type such as broadside or rear-end. When analyzing bike crashes, it is more useful to look at the primary collision factor (PCF) e.g. running a stop sign or red light. Selecting appropriate countermeasures can be even more effective when one also considers party-at fault, since different interventions are effective for cyclists vs. motorists. Furthermore, since cyclists (as opposed to motorists) can be children, it is essential to separate the crashes caused by child-cyclists. This too can lead to different interventions, mainly educational but also infrastructure and enforcement. This poster illustrates the importance of analyzing bicycle crashes by party-at-fault and cyclist age. It first presents the crash history of five cities as one data set. Then the same crashes are disaggregated into three categories: motorists-at-fault; adult cyclists-at fault, and child cyclists at-fault, which reveals different conclusions as to the most common crashes in the community. The poster illustrates that by analyzing crash data by both party-at-fault and cyclist age, useful statistics emerge such as the most common motorist-at-fault crashes in some cities is hitting cyclists with car doors.

**keywords:** bike collision, primarycollision factor, road safety



**Do we learn more from complex accident coding?**

Author(s): Carl Johnsson, Aliaksei Laureshyn, Anna Björnberg

Presenter: Carl Johnsson (carl.johnsson@tft.lth.se)

*Transport and Roads, Faculty of Engineering, Lund University, Lund, Sweden***ABSTRACT**

STRADA, the Swedish national accident database, has a great advantage of containing hospital records with cyclist injuries that are seldom reported by the police. On the other hand, the accident typology used is very limited, especially when compared to the German and Danish databases that have an elaborate system to code the manoeuvres of road users involved in the accidents. In this exploratory study we investigated to which extent introduction of a more detailed accident coding can enhance the usefulness of STRADA. We manually examined all serious or fatal injury accidents records involving cyclists & pedestrians during 2009-2013 in the cities of Gothenburg and Malmö (2nd and 3rd biggest cities in Sweden). Totally 734 accidents were examined, 243 of them involving cyclists. The majority of the cyclist accidents (60%) were single accidents, registered by hospitals only and thus missing information on the course of events. The remaining 90 accidents (registered by police) contained a sketch from which the manoeuvres of the involved parties could be extracted. The CADaS accident typology was applied, as enhanced with additional codes for road markings, regulation, sight conditions, etc. The conclusions are: • Accident classification similar to CADaS provides much more versatile view of the cyclist safety problems; • However, going into more disaggregation quickly results in very few accidents per type and become meaningless; • It is important to explicitly identify the cyclist in the accident sketch; • Hospital data contribute a lot to understanding the extent of the safety problems, but not as much to understanding the conditions of the accidents.

**keywords:** Accident typology, Sweden, Single accidents***Bicycle Accidents in Argentine Youth. A Survey Study in Five Mid-Sized Cities.***

Author(s): Ruben D Ledesma, Fernando M Poó, Carlos M. Díaz-Lázaro, Jorge F. Ungaro

Presenter: Ruben D Ledesma (rdledesma@gmail.com)

*Universidad Nacional de Mar del Plata, Mar de Plata, Argentina***ABSTRACT**

Knowledge on mobility and road injuries among cyclists in Argentina is scarce. This work presents some indicators of bicycle use and accidents in adolescents and young adults. Gender, age, and city differences are analyzed. A total of 10390 Argentine youth (15 to 25 years of age) from five cities participated in the study. Instrument: A survey developed in the context of a broader project on road safety (SR4Y) was used. It included a section on mobility and accidents (including those as cyclist). Youth were mostly accessed through educational institutions where they responded anonymously to surveys. Data were analyzed descriptively and by using logistic regression techniques. Twenty-eight percent of youth uses the bicycle as a habitual means of transportation. Its use decreases with age. A 4.2% of the total sample reported experiencing a bicycle accident in the last 3 years. That percentage increases to 9% among those who habitually use the bicycle. A 46% of those reporting an accident also indicated requiring medical attention. The risk of accidents is greater for men as compared with women. No age differences were found. There were differences based on city, although these can be attributed to exposure factors (higher level of bicycle use). Mobility policies are needed in order to promote bicycle use (particularly after reaching the driving age) in conjunction with road safety plans focusing on urban cyclists. More research is needed to guide these actions and policies.

**keywords:** Youth, Accidents, Survey

***Pedelecs: Designing Cities for Bicycling's Future***

Author(s): Kevin J. Krizek

Presenter: Kevin J. Krizek (kjkkrizek@gmail.com)

University of Colorado Boulder, Boulder, CO, USA

**ABSTRACT**

The transport portfolio of most cities globally is changing quickly (e.g., technological and other pressures are flexing their muscles, yielding a tremendously uncertain and confusing space). Recognizing gains cycling has realized in recent years, it is still a fringe mode in most cities. Advances in e-bikes will likely enhance cycling's market share. Yet, technological advances push the bicycle further toward motorized transport (bikes bearing resemblance to smaller cars). This presentation first offers an evidence-based threshold by which a pedelec bicycle retains cycling's inherent characteristics (i.e. guided by cycling as an active form of transport and by basic levels of cognition of humans). Next, this work clearly defines parameters for how bicycles/pedelecs might interact with other emerging forms of transport what will increasingly being using the rights of ways in cities. -Reconciling the emerging forms of electric bicycling on city streets is a technical, cultural, & political issue. Relying on thresholds informed by cross- disciplinary fields, this paper offer definitions and rationales for the upper limit of propulsion to be offered by pedelec bicycles and inevitable contentious points for how they might interact with autonomous vehicles. Conclusion-Pedelecs may likely assume an important/emerging role in the design for the future of cities. Defining that role is and explain a plan for its onset is this paper's contribution.

**keywords:** city design, pedelecs, autonomous vehicles***Safety in Numbers, in Pisa too.***

Author(s): Marco Bertini, Pisa Bike Office person in charge

Presenter: Marco Bertini (bertinim@pisamo.it)

PISAMO - Agency for the Mobility SpA, Pisa, Italy

**ABSTRACT**

We are now building a geo-referenced data-base of the accident risk using the localisation of accidents occurring in Pisa. Local police since 2013 do a little data entry by inserting geographic reference (lat and long) together with time, type oh vehicles involved, date and hour of accident. As a result, we have a risk-map about street accidents. Thanks to CNR (<http://tagmyday.isti.cnr.it/node/330>) we obtained a bike-use-map based on real observation of local trips made with GSM localisation. This map will soon help to design the new bike-plan about future bike lanes. But also to act with a better knowledge about cyclist behaviour (and accident risk). We are not surprised, but evidence tell us that where bicycles are more, accidents are less...

**keywords:** evidence, numbers, tag

***On the relation between bicycle volumes and individual risks for bicyclists in Berlin***

Author(s): Leonhard Lücken and Peter Wagner

Presenter: Leonhard Lücken (leonhard.luecken@dlr.de)

*Institute of Transportation Systems, German Aerospace Center (DLR), Berlin, Germany***ABSTRACT**

A notoriously difficult problem in traffic safety is the verification of the so-called "safety-in-numbers" (SiN) effect. This term refers to the observation that the individual risk  $R$  for a road user is inversely related to the absolute number  $X$  of road users of the corresponding type and suggests that a larger number of such road users is the reason for an increase of their individual safety. We propose a model to identify the causal relation between the correlated phenomena. It includes temporal information to verify which of the correlated phenomena precedes the other. We employ the model for an analysis of bicycle volumes and crashes between bicycles and motorized vehicles in Berlin, where different temporal and spatial aggregation levels are considered. Interestingly, we find a slight indication for a SiN-effect on an annual scale while more fine-grained temporal resolutions rather indicate the opposite effect of increasing risks due to higher volumes.

**keywords:** safety in numbers, delay model, causal relation, bicycle crashes, bicycle volume model, ratio variables

***Investigation of the impact of topography and cyclist type on speeds on pedestrian-bicycle paths***

Author(s): Miroslav V. Vasilev, Kelly Pitera

Presenter: Miroslav V. Vasilev, Kelly Pitera (miroslav.vasilev@ntnu.no)

*Department of Civil and Transport Engineering, Norwegian University of Science and Technology, Trondheim, Norway***ABSTRACT**

Volumes and diversity of users on pedestrian-bicycle paths in Norwegian cities are expected to increase in the future. Insufficient space for meetings and passages poses safety concerns, especially on downhill where cycling speeds are higher. To address this, the impact of the various topography on users' speeds will be assessed. Additionally, different types of users will be categorized to establish average speeds for each group. A method for registering speeds used by Buch and Greibe (2014) is the most suitable for the needs of this study. Video footage is taken by two camcorders situated 20m apart along uninterrupted, separated paths with varying slopes. Software using two measurement lines on each of the matched pairs of videos from a given path allows the speeds of each user to be measured. It is expected that path users can be separated into groups based on their speeds. The user groups are: e-bikers, utility, elderly, child, and sport cyclists, pedestrians and runners. Their speeds will be related to the path's slope, although on steep downhill user groups' comfort with speed will also be influential. Having greater knowledge on the speeds of different user groups on different topography will be useful as we continue to study and design for diverse cycle populations and expand cycle networks. Designing facilities that adequately serve pedestrians and cyclists increases the attractiveness and influences safety of these modes.

**keywords:** cyclist, slope, speed

**Cycling Comfort: a Web-Based Application of Vibration Measurement**

Author(s): Michal Bíl, Jan Kubeček, Richard Andrášik

Presenter: Michal Bíl (michal.bil@cdv.cz)

CDV - Transport Research Centre, Brno, Czech Republic

**ABSTRACT**

Vibrations of bicycles negatively influence riding comfort. Uneven surface pavement is the principal source of vibrations. We have developed a simple and effective method for objective bicycle vibration measurement using GPS and accelerometer devices mounted on a bicycle. The advantage of this approach is its simplicity and transferability because various bicycle types can be used to obtain data on vibration. A dynamic comfort index (DCI) was derived to objectively describe the range of vibration. We have compared the DCI with the subjective opinions of several test riders. The results indicate a strong correlation between the DCI and the median of subjective opinions which means that DCI can also be used as a general description of the average feeling of cyclists when riding over the given surface pavement. The resulting DCI can be linked via GPS data to respective geographic positions. This task still has to be carried out in a GIS. We present a free web-map service which processes data up-loaded by users. The results are in the form of line shapefiles containing geo-localized DCI.

**keywords:** Dynamic comfort index, Web-map, Vibration**Cycling Anger: Regular Cyclists vs. Professional Bicycle Messengers**

Author(s): Michael Oehl, Birte Emmermann, Stefan Brandenburg, Anja K. Huemer

Presenter: Anja K. Huemer (oehl@uni.leuphana.de, a.huemer@tu-braunschweig.de)

Department of Engineering and Traffic Psychology, Technische Universität Braunschweig, Braunschweig, Germany

**ABSTRACT**

Cycling anger defined as the propensity of cyclists to become angry in traffic is a concept so far rather neglected in research. Research on emotions in traffic has been focusing rather on car drivers than on cyclists. On the basis of previous qualitative research a questionnaire was developed assessing cyclists' anger experience in interaction with their cycling environment. This current study aimed at a further validation of the Cycling Anger Scale (CAS) using different samples of cyclists (regular cyclists vs. professional bicycle messengers). Factor analyses proposed again four subscales of the CAS, i.e., police interaction, car interaction, cyclist interaction, and pedestrian interaction. Cross-validation supported these results. Alpha reliabilities were acceptable to good. The CAS correlated significantly with the Driving Anger Scale for car drivers and with the general State-Trait Anger Expression Inventory suggesting convergent validity and providing a complementary instrument for measuring cycling anger in traffic. Bicycle messengers experienced generally less anger than regular cyclists. For both cyclist groups significant correlations between cycling anger and self-reported risky cycling behaviour was observed. The CAS provides a valid and efficient measure assessing cyclists' anger experience in traffic. Its application in research and applied issues, i.e., aggression prevention, will be discussed.

**keywords:** Anger, cycling, bicycle messenger

***Fresh Brains – Bicycle audits by Dutch and German planning students in German municipalities***

Author(s): Isabelle Ork, Anne Timmermann

Presenter: Isabelle Ork, Anne Timmermann (ork@uni-wuppertal.de)

*Department of Road Traffic Planning and Engineering, University of Wuppertal, Wuppertal, Germany***ABSTRACT**

The aim of the project "Fresh Brains" is the promotion of cycling in German municipalities through a "fresh view" and the transfer of Dutch knowledge. Therefore teams of German and Dutch students perform analyses of 4 selected municipalities and derive recommendations to promote cycling on site. The chosen municipalities have a low level of cycling, low cycling promotion and rather "bad" conditions for cyclists. The mission statement "cycling as a system", which provides an integrated and comprehensive cycling policy, shows that there is not only a bike-friendly infrastructure to be developed, but also the field of public relations, communications, education and services. This concept divides the cycle planning and promotion into three HOS-"pillars": hardware, orgware and software. These should all be equally well designed so that the system is safe and of good quality. To get a first overview of the potential of development an HOS checklist was developed and applied to the different cities considering among other issues road safety and safety of cyclists. Following that the students work in small groups, determining strengths and weaknesses (SWOT-analysis) of the current cycling development scheme and exemplifying opportunities for improvements with an "external" and "fresh" view to the local situation. The students derive a framework for cycling promotion for three HOS-"pillars" in each city to get a balanced system with safe and good quality for cyclists.

**keywords:** Bicycle audits, Cycling as a system***Requirements for a test environment and a driving situation catalogue for bicycle driver systems***

Author(s): Felix Dauer

Presenter: Felix Dauer (felix.dauer@de.bosch.com)

*Robert Bosch GmbH, Baden-Württemberg, Germany***ABSTRACT**

Development and testing of driver systems in the two-wheeler sector are gaining importance. This creates new demands on appropriate test environments such as reproducibility, flexibility and proximity to reality. A test environment in the form of a remote-controlled bicycle without a human cyclist allows a reproducible cycling behavior that can be compared to simulation results. This approach requires a test dummy fixed on the bicycle and accelerating the bicycle to a determined speed. Furthermore, a steering and braking actuation, ideally remotely controllable, has to be realized and different sensor data have to be logged for evaluation. In addition, it is necessary to formulate a comprehensive test catalog with representative driving situations. The right choice of driving situations requires a detailed analysis of typical driving situations and the critical parameters. Based on these driving situations, specific tests of different bicycles and different cyclists can be carried out. Each situation must be considered individually, since the bicycle parameters such as rider weight, different braking systems and frame geometries and also external conditions such as the road surface, affect the test results. The goal of the test environment and the driving situation catalogue is to evaluate and optimize different driver systems and the associated sensor systems.

**keywords:** test environment, driving situation catalogue, reproducible testing behavior

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[icsc106@unibo.it](mailto:icsc106@unibo.it)