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A Taxonomy of Countermeasures for Cyclist – Vehicle Crashes

Nazli E. Kaya
Birsen Donmez

Human Factors
& Applied Statistics Lab

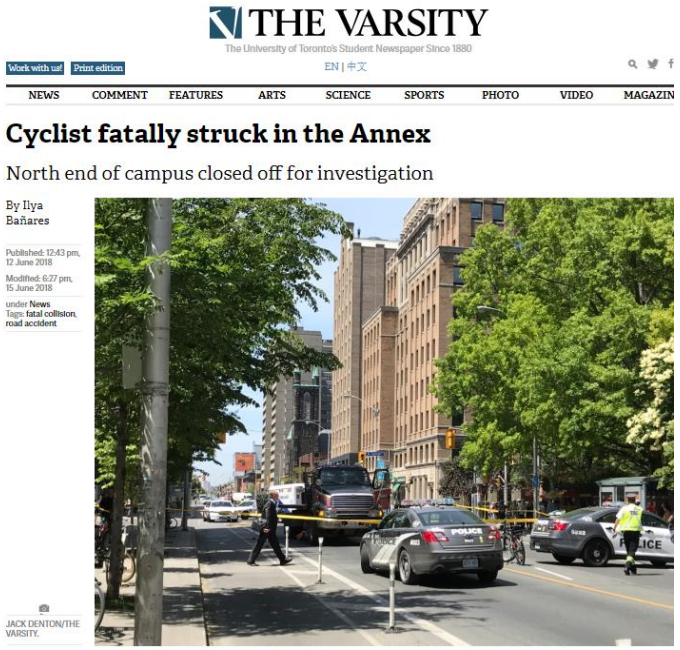
Mechanical & Industrial Engineering
UNIVERSITY OF TORONTO

Cycling Safety within Motor Vehicle Traffic

- Cycling is experiencing a growth in urban areas
  - An increase of 31% in Toronto from 2001 to 2006 (Toronto Public Health, 2012)
- Majority of cyclist crashes occurring in busy city cores
  - 69% of cyclist fatalities are in downtown Toronto (Toronto Public Health, 2012)
- Cycling safety within vehicle traffic appears to be deteriorating
  - **2016**: Cyclist fatalities accounted for **2.2%** (840) of 37,461 total fatalities (National Center for Statistics and Analysis, 2018)
  - **2007**: Cyclist fatalities accounted for **1.7%** (701) of 41,259 total fatalities (National Center for Statistics and Analysis, 2018)
  - Controlling for number of trips taken, U.S. cyclists are 2.3 times more likely to die in a crash compared to a vehicle occupant (Beck, Dellinger, & O'Neil, 2007)

Cycling Safety: A Greater Concern

- Underreporting of cyclist crashes to police is worldwide problem (Shinar et al., 2018)
  - Police reports showed 26% decrease in cyclist serious injuries, whereas hospital records indicated a 35% increase (OECD/International Transport Forum, 2013)
  - Police-reporting rate was only 3.9% for crashes with no medical attention (Shinar et al., 2018)
- Overall, cycling safety is a great concern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Cyclist fatally struck in the Annex

North end of campus closed off for investigation

By Ilya Bañares

Published: 12:43 pm, 12 June 2018

Modified: 6:27 pm, 15 June 2018

under News

Tags: fatal collision, road accident

JACK DENTON/THE VARSITY

Source: Varsity Newspaper

Visual Attention Failures at Intersections

Current Instrumented Vehicle Study

- Driver visual attention failures towards vulnerable road users at intersections
- **Road Design**:
  - Busy & Risky Intersections (Carter, Hunter, Zegeer, Stewart, & Huang, 2007)
  - Control Types: Signalized, Stop-sign, Uncontrolled
- **Individual Differences:**
  - Cycling Exposure: Cyclist Drivers vs. Non-cyclist drivers
  - Aberrant Behaviours: Post-drive Questionnaires
  - General Attention Capability: Post-drive Attention Tasks

Proposed Taxonomy

ROAD USER
DRIVER
CYCLIST

Proposed Taxonomy

ROAD USER	Vehicle/Gear
DRIVER	Maintenance e.g., quality of windshield wipers Assistive Car Technology e.g., blind spot detection
CYCLIST	Maintenance e.g., tire pressure Detection Enhancing Gear e.g., reflective vest, bell Assistive Bicycle Gear e.g., rear-view mirror on bicycle Protective Gear e.g., helmet

Proposed Taxonomy

ROAD USER	Vehicle/Gear	Infrastructure
DRIVER	Maintenance e.g., quality of windshield wipers Assistive Car Technology e.g., blind spot detection	Maintenance e.g., adequate quality of road surface Control Elements e.g., dedicated bicycle signals Road Layout e.g., dedicated bicycle lanes
CYCLIST	Maintenance e.g., tire pressure Detection Enhancing Gear e.g., reflective vest, bell Assistive Bicycle Gear e.g., rear-view mirror on bicycle Protective Gear e.g., helmet	

Proposed Taxonomy

ROAD USER	Vehicle/Gear	Infrastructure	Policy Design
DRIVER	Maintenance e.g., quality of windshield wipers Assistive Car Technology e.g., blind spot detection	Maintenance e.g., adequate quality of road surface Control Elements e.g., dedicated bicycle signals Road Layout e.g., dedicated bicycle lanes	Education & Training e.g., right-of-way knowledge Regulatory Laws e.g., no right-turn-on-red Enforcement e.g., fines for motor vehicle intrusion to bicycle facilities
CYCLIST	Maintenance e.g., tire pressure Detection Enhancing Gear e.g., reflective vest, bell Assistive Bicycle Gear e.g., rear-view mirror on bicycle Protective Gear e.g., helmet		Education & Training e.g., avoiding wearing black clothing Regulatory Laws e.g., license plates for bicycles Enforcement e.g., detection system for violations

Vehicle/Gear

- Proper ***maintenance of vehicles*** (cars and bicycles)
  - Proper tire type and pressure (Rievaj, Vrábel, & Hudák, 2013)
  - Working windshield wipers and signals (Bernardin et al., 2014)
- ***Assistive car technologies*** can help drivers
  - Blind spot detection technology with about 78% precision rate of other vehicle and motorcycle detection (Ra, Jung, Suhr, & Kim, 2018)
  - Peripheral cues on a head-up display (Gruenefeld, Löcken, Brueck, Boll, & Heuten, 2018)
  - Omnidirectional warnings (Meng & Spence, 2015)
  - Assistance in vehicle control (e.g., automatic braking) (Endsley, 2017)
  - Developing smarter vehicle and infrastructure systems (Silla et al., 2017)

Bicycle-related Gear

- Cyclist visibility plays a large role in their detection
  - Wearing fluorescent and reflective vests
    - The importance of reflective clothing appears to be recognized more by drivers (95% of surveyed drivers) than by cyclists (72% of surveyed cyclists) (Wood et al., 2009)
  - Installing pedal reflectors and flashing or steady lights (OECD/International Transport Forum, 2013)
    - Daytime usage lights correlated with a 30% reduction (Madsen & Overgaard, 2006)
- Improved cycling performance via ***assistive bicycle gear***
  - Installing a rear-view mirror on the bicycle
  - Wearing gloves and sunglasses
- ***Protective gear*** can reduce crash impact
  - Helmet wearers are significantly less likely to experience fatality (odds ratio, OR: 0.27) and head injury (OR: 0.40) (Attewell, Glase, & McFadden, 2001)
    - Highly recommended but not compulsory in many jurisdictions (Wegman, Zhang, & Dijkstra, 2012)

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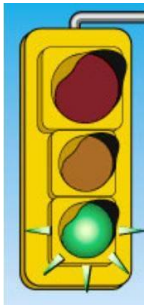
Infrastructure: Maintenance and Control Elements

- Proper ***maintenance*** of road and bike paths are critical
  - Poor pavement quality is deterrent to cycling (Pucher et al., 2010)
  - Obstacles on cyclists' path can create distractions (84% of surveyed cyclists) (Useche, Alonso, Montoro, & Esteban, 2018)
  - Adequate road lighting should also be ensured given that cyclist fatality probability is higher by 111% on dark, unlit roads (Kim, Kim, Ulfarsson, & Porrello, 2007)
- Informing and directing through ***control elements***

Signal countdown
(Sharma, Vanajakshi, Girish, & Harshitha, 2011)



Flashing green prior to the amber phase
(Mussa, Newton, Matthias, Sadalla, & Burns, 1996)

Flashing amber beacon at stop-controlled intersections

Bike box: 30% reduction in car-bicycle conflicts

Dedicated bicycle signals
(Korve & Niemeier, 2002)

University of Toronto


(Dill, Monsere, & Mcneil, 2011)

(Srinivasan et al, 2008)

Infrastructure: Road Layout

- Separating cyclists from motor vehicle traffic
  - Mixed traffic is a source of driver attention failures (Robbins & Chapman, 2018) and cyclist distraction (Useche, Alonso, et al., 2018)

On-street parking lanes also can act as a buffer (DiGioia, Watkins, Xu, Rodgers, & Guensler, 2017)

- dooring (City of Toronto, 2017)
- blocking the drivers' view of cyclists at intersections (Kaya et al., 2018)

Infrastructure: Cycle Tracks

- Cycle tracks are the most effective for preventing injury
  - Risk ratio compared to a similar road without any ≈ 0.12 (DiGioia et al., 2017)
  - Their effectiveness may degrade at intersections
  - **Undisrupted pathways for cyclists through intersections**

Infrastructure: Road Diet

Introducing or adding bike lanes to an area (DiGioia et al., 2017)

Removal of on-street parking lanes: Risk ratio compared to a similar road with a parking lane ≈ 0.61 (DiGioia et al., 2017)

Vehicle-free streets (Pucher et al., 2010)

2+1 lanes: 29% reduction in the total number of collisions and speed (Tan, 2010)

Removal or separation of streetcar and railroad tracks (Teschke et al., 2012)

2+2 lanes without a bike lane (Tan, 2010)

2+1 lanes with a bike lane (Tan, 2010)

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Policy

- ***Education*** and ***training***:
  - Raising awareness
  - Correcting misinformation
  - Promoting safer actions
  - An example: Cycling mentorship program (Savan, Cohlmeyer, & Ledsham, 2017)
    - Bicycle loan and planning local rides& routes
    - After 16 weeks: 25% of the trips by bicycle and 84% increase in willingness to spend on bicycle accessories
- ***Regulatory laws*** and ***enforcement:***
  - Mandatory helmet use (?)
  - License plate for bikes (Halfords, 2017)
  - Distraction prevention for cyclists (Useche et al., 2018)
  - No RTOR (Preusser et al., 1982)
  - Fines for motor vehicle intrusion to bicycle path (OECD/International Transport Forum, 2013)

Key Takeaways

- Infrastructure-related countermeasures are the most effective: Separation of cyclists from vehicle traffic
- Rigorous evaluations of different interventions needed
- Technological advances provide further assistance
  - Current systems are not yet mature enough (Silla et al., 2017)
  - Maladaptation might emerge
- Road transportation is a complex system with many agents
  - Systems approach for human error management (Reason, 2000)
  - Different interventions in combination

Dehumanization of cyclists predicts self-reported aggressive behaviour toward them: A pilot study

Alexa Delbosc [a], Farhana Naznin [a], Nick Haslam [b], Narelle Haworth [c]

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https://doi.org/10.1016/j.trf.2019.03.005

Highlights

- Conducted a pilot test of the dehumanization of cyclists.
- Around half of non-cyclists view cyclists as 'less than fully human'
- Dehumanization measures were significantly correlated with aggression toward cyclists.
- 'Dehumanization of cyclists' concept deserves further research.

Acknowledgement

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Questions?

Nazli E. Kaya
nkaya@mie.utoronto.ca

CBC Interview: http://tiny.cc/cbc-eyetracker

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