New technologies for vulnerable road users : some examples for pedestrians' safety and mobility

Aurélie Dommes

University Gustave Eiffel – IFSTTAR
PICS-L Laboratory

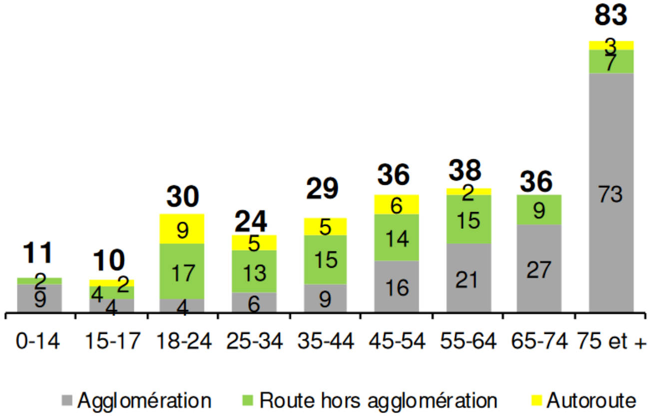
aurelie.dommes@ifsttar.fr

Pedestrian crash statistics in France (ONISR, 2018)

=> Pedestrian deaths are about 14% of all road fatalities
(in 2018, 470 pedestrians have been killed).

✋ Compared to other road accident victims, the part of pedestrians killed in mortality has increased: from 11% in 2000 to 14% in 2018.

% of pedestrians killed on road per age group (ONISR, 2018)



- People aged 75 years and over :
  - 9 % of the French population
  - 40 % of pedestrians killed on the road

- in cities (compared to rural areas)
- and in daylight conditions

=> Older pedestrians are overrepresented in pedestrian crash statistics
in most European countries (OECD, 2011)
as well as in the US (NHTSA, 2001),
in Australia (Australian Transport Safety Bureau, 2002)
or in Japan (Dunbar et al., 2004)

=> Pedestrians' safety is actually an international issue.

To understand these crash statistics
and to find ways to improve them, more and more research
is being conducted on the issue of pedestrians’ safety.

The challenge of automation has also increased the
research on pedestrians’ interactions with vehicles.

=> examples of research we have done about new technologies to improve pedestrians' safety and mobility

Older pedestrians training studies with virtual reality

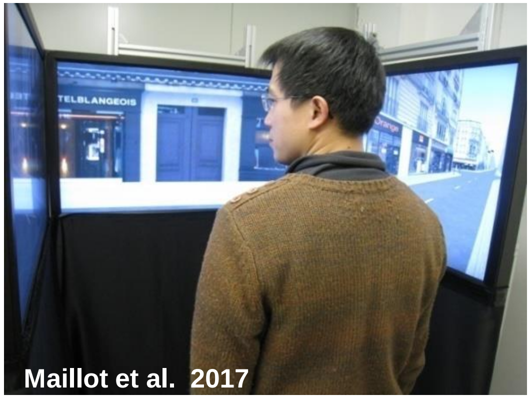
The effectiveness of prevention and education?

⇒ **Simulator training programs were able to improve and change behavior**

✋ disseminate widely among the population

The effectiveness of training programs?

behavioral



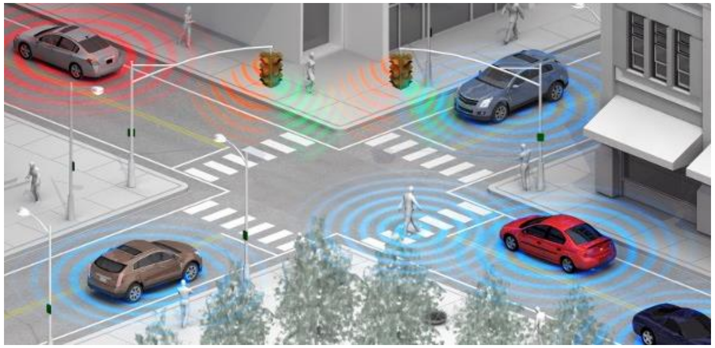
cognitive

Maillot, P., **Dommes**, A., Dang, N.-T., & Vienne, F. (2017). Training Elderly in Pedestrian Safety: Transfer Effect Between Two Virtual Reality Simulation Devices. *Accident Analysis and Prevention*, 99, 161-170.

Dommes, A., & Cavallo, V. (2012). Can simulator-based training improve older pedestrians' safety? *Transportation Research Part F: Traffic Psychology and Behaviour, 15,* 206-218.

Dommes, A., Cavallo, V., Vienne, F., & Aillerie, I. (2012). Age-related differences in street-crossing safety before and after training of older pedestrians. *Accident Analysis and Prevention*, 44, 42-47.

Technological devices : V2P communication ?



Technological devices allowing communication between pedestrians – vehicles – infrastructure

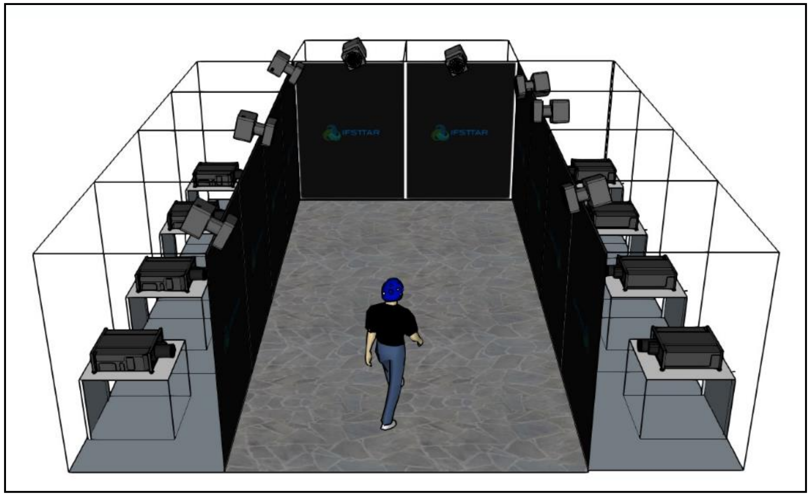
guiding street-crossing decisions?

Technological devices : V2P communication ?

We have designed and tested the effectiveness of a technological device allowing communication between pedestrians – vehicles – infrastructure

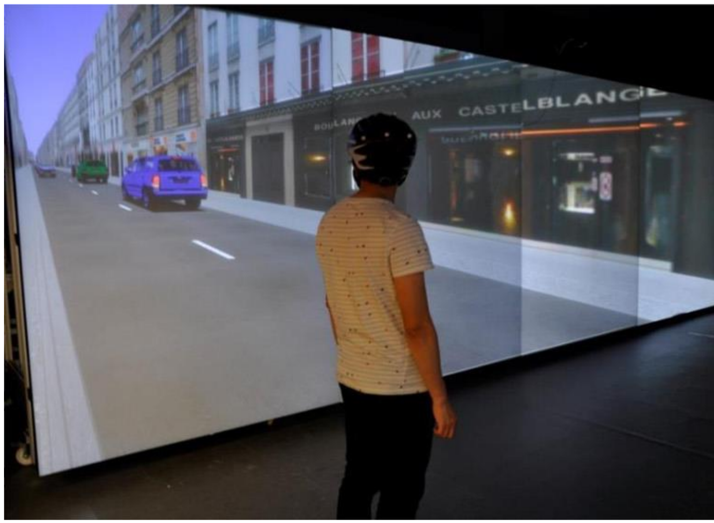
⇒ Tests were run in a **<u>virtual environment</u>** to accurately emulate all of the necessary communication between the infrastructure, the vehicles and the pedestrians (e.g., localization with millimeter precision).

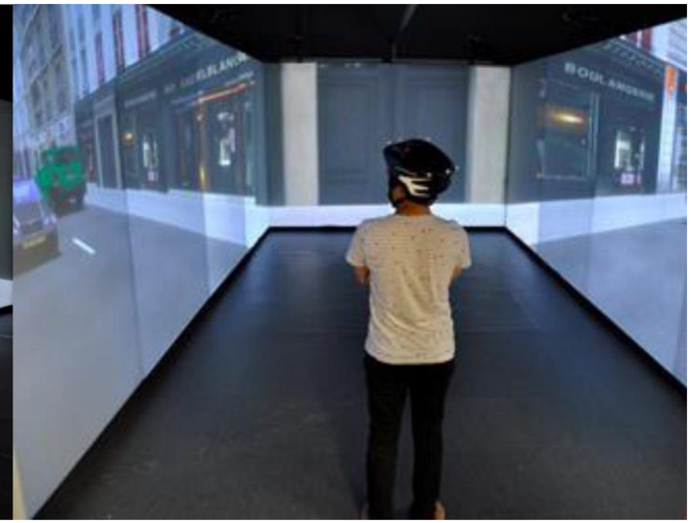
⇒ This is not yet available with current technologies, but could become possible in the near future with increasing research and development of connected objects and autonomous vehicles.



Participants were wearing a connected watch while answering a street-crossing task on the simulator.

The watch vibrates very strongly around the participant’s wrist to tell the participant that crossing is dangerous.



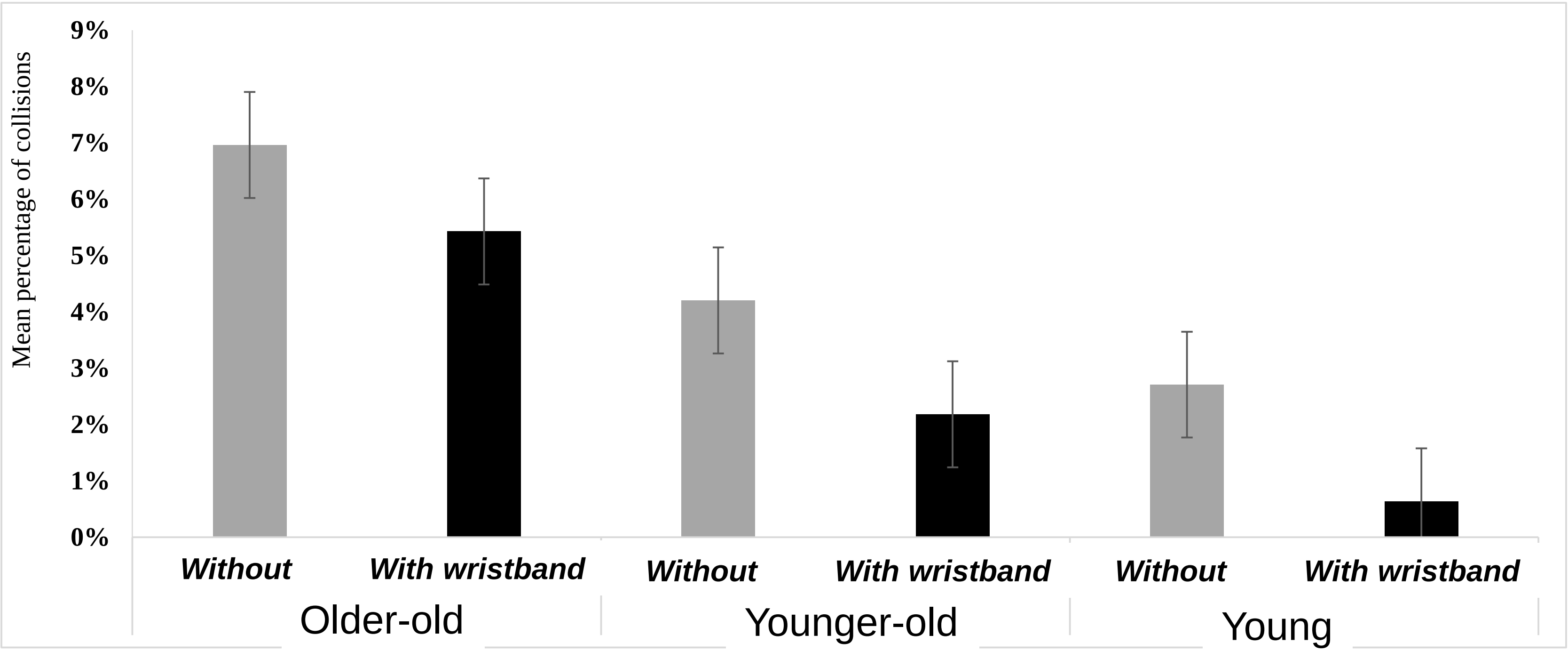


Most notable findings

« subjectively perceived as useful » by all participants

« objectively useful »: dangerous crossing decisions were reduced (θ)

« limited trust »: 50% of correct answers (*i.e. messages were challenged ; participants deliberately chose to cross against the prevention messages, a too much guiding system, they felt like a robot*)

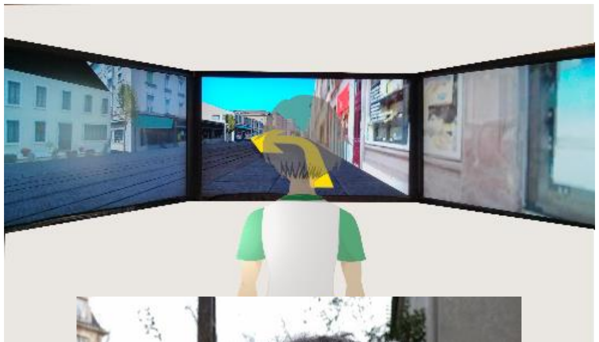


Coeugnet, S., **Dommes**, **A.**, Panëels, S., Chevalier, A., Vienne, F., Dang, N.T. & Anastassova, M. (2017). A vibrotactile wristband to help older pedestrians make safer street-crossing decisions. *Accident Analysis and Prevention*, 109, 1-9.

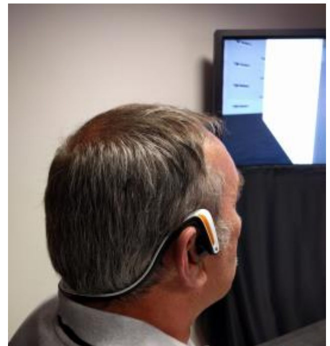
Assess the effectiveness of guiding pedestrians in an unknown urban environment with visual, auditory, haptic feedbacks

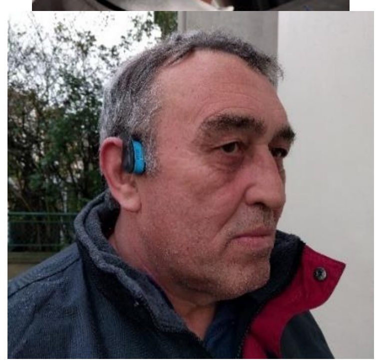
Arrows inlayed

in the visual field of view, AR glasses

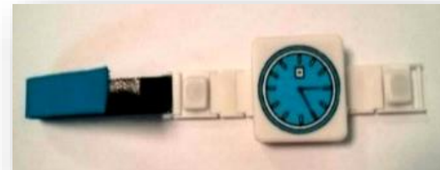


Bone conduction headphone





vibrotactile wristband, smart wtach



Maps

Several advantages and limits according to :
- the age of the pedestrian *(maps ≠ devices providing information directly “on” the pedestrian)*
- the complexity of the information to deliver *(ex. roundabouts)*
- users’ experience *(discretion of the device, attention sharing, trust, etc.)*

Montuwy, A., **Dommes**, **A.**, & Cahour, B. (2018). Helping Older Pedestrians Navigate in the City: Comparisons of Visual, Auditory and Haptic Guidance Instructions in a Virtual Environment. *Behaviour and Information Technology*, 38(2), 150-171.

Montuwy, A., Cahour, B., & **Dommes**, **A**. (2019). Using sensory wearable devices to navigate the city: effectiveness and user experience in older pedestrians. *Multimodal Technologies and Interaction*, *3*(17), 1-24.

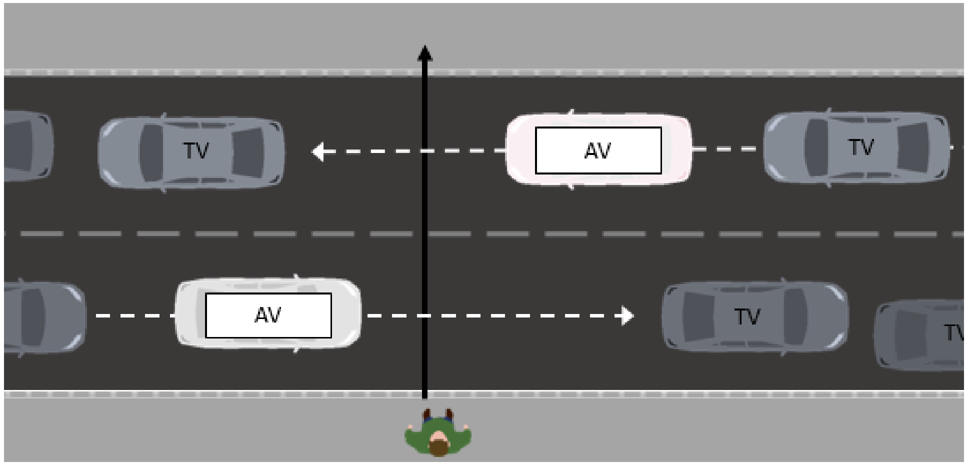
Interactions of pedestrians with automated vehicles



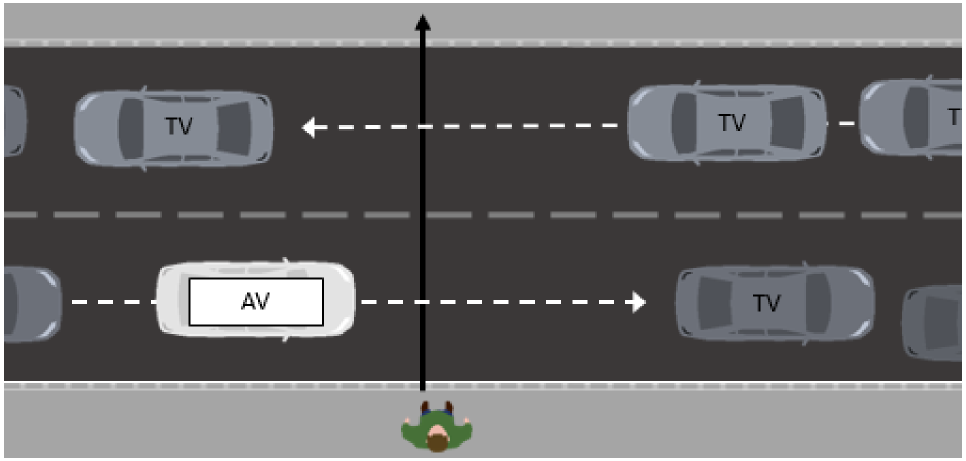

Studying pedestrians’ interactions with automated cars to know if street-crossing behaviors will change.

30 young participants and 30 older participants participated in a simulated street-crossing experiment and perform a real walk across an experimental two-way street.
They could either cross in front of automated cars that were programmed to always stop and let the pedestrian cross, or between traditional cars that approached at a constant speed and did not brake to let the pedestrians cross,

This work is supported by grants from the French Minister of the Interior, and from the Road Safety Department more particularly



When crossing in front of an automated car in each lane of the two-way street, safety (systematic stop) but distrust were observed by later initiations and longer crossing times, especially when automated cars approached at short distances.



When an automated car gave way to pedestrian in the first lane while traditional cars (not yielding) were approaching in the second lane,

⇒ risky behaviors (collisions) were observed, in young and older participants

⇒ participants answered the opportunity offered by the automated car in the near lane but without sufficiently considering the far lane.

Designing new technologies for vulnerable road users

Designers have to adress some dilemmas,
to create devices that are desirable (human), feasible (technical), and viable (business).
But answering all of these constraints is sometimes difficult…

Some psychological criteria for designing new technologies:

Net resource release

Technology needs to release more cognitive resources for other tasks than are needed for its operation (marginal benefit)

Assessment of net resource release involves subjective and objective criteria

Assessment of net resource release needs to go beyond the target domain of assistance

Person specificity

Aging is highly variable across and within individuals

Aging individuals possess exquisite implicit and explicit knowledge about the organization of their habits and goal-directed actions

Intelligent human engineering technologies need to operate as learning devices that provide idiosyncratic support structures based on cues generated by the user's behavior

Proximal versus distal frames of evaluation

The effects of technology are modulated by historical and ontogenetic context; benefits of technology vary by timescale and domain

Long-term risks: Chronic technological assistance may deplete resources through disuse

Long-term benefits: By optimizing the balance between 'environmental support' and 'self-initiated processing' [42], technology may uncover latent potential (technology as a source of plasticity)

Lindenberger, U., Lövdén, M., Schellenbach, M., Li, S.C., & Krüger, A. (2008). Psychological principles of successful aging technologies: a mini-review. *Gerontology*, *54*(1), 59-68.

⇒ *for older people, but in terms of universal design, if a device is accessible, usable, convenient and a pleasure to use for them, everyone benefits*

New technologies for vulnerable road users : some examples for pedestrians' safety and mobility

Aurélie Dommes

University Gustave Eiffel – IFSTTAR
PICS-L Laboratory

aurelie.dommes@ifsttar.fr