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Drivers' gap acceptance in front of approaching bicycles – Effects of bicycle speed and bicycle type

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E-bikes and cycling speed

- E-bike sales figures on the rise in Europe (e.g., ZIV, 2013) and worldwide (e.g., Rose, 2012; Weinert et al., 2007)
- E-bikes can and indeed do reach higher speeds than conventional bicycles (e.g., Schleinitz et al., 2014; Cherry & He, 2009)
- E-bike riders consider the potential underestimation of their speed by a motorised vehicle as one possible hazard (Alrutz, 2013)

So - how do other road users cope with the fact that there now is something on the road that looks like a normal bicycle, however accelerates much faster, and reaches quite different speed levels than a conventional bicycle?

Drivers' gap acceptance

- Stable effect of drivers (and other road users) accepting smaller (time) gaps when the approaching vehicle is faster, e.g.
  - Cooper, Storr, & Wennell (1977) – field observation of vehicle turning manoeuvres at a T-junction
  - Alexander, Barham, & Black (2002) – driving simulator study with participants required to turn across a lane with oncoming traffic
  - Petzoldt (2014) – video based study on pedestrian crossing decisions
- However, previous studies usually required participants to cross in front of a motorised vehicle, with comparatively high and distinct approach speed levels (40 km/h and above, difference between conditions 20 km/h and more)

Drivers' gap acceptance in front of approaching bicycles

- What gap sizes do drivers choose when confronted with an oncoming bicycle? Does the effect of speed also occur with the comparatively low cycling speeds? And does it also occur with relatively small variations?
- Also:
  - Do the bicycle type (conventional vs. e-bike),
  - the route profile (flat vs. uphill),
  - the observer's perspective (front view vs. sideview), or
  - the observer's age (30-45 years vs. 65 years and older) influence the size of accepted gaps?

Method - Gap acceptance study on a „test track“

Participants

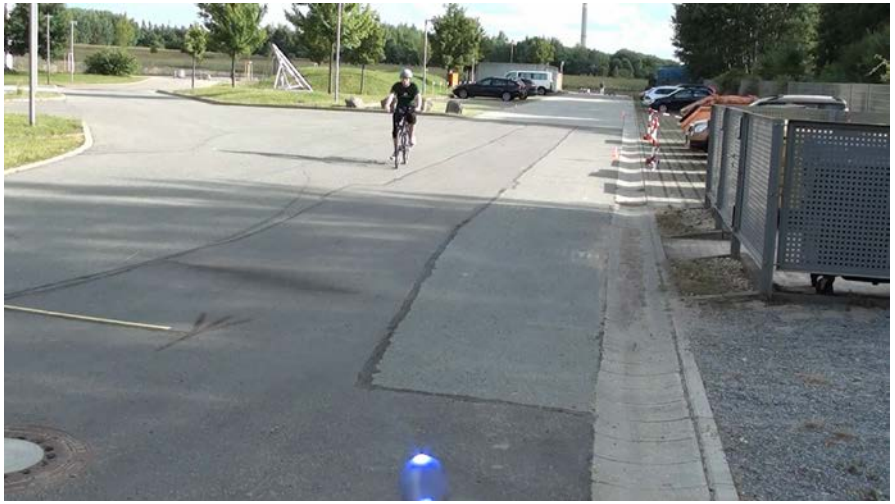
Age group	female	male	Total		
	N	N	N	M_{age}	SD_{age}
30-45	8	13	21	34.0	4.4
65 +	3	19	21	71.1	5.0

Experimental conditions

- Bicycle type – conventional vs. e-bike

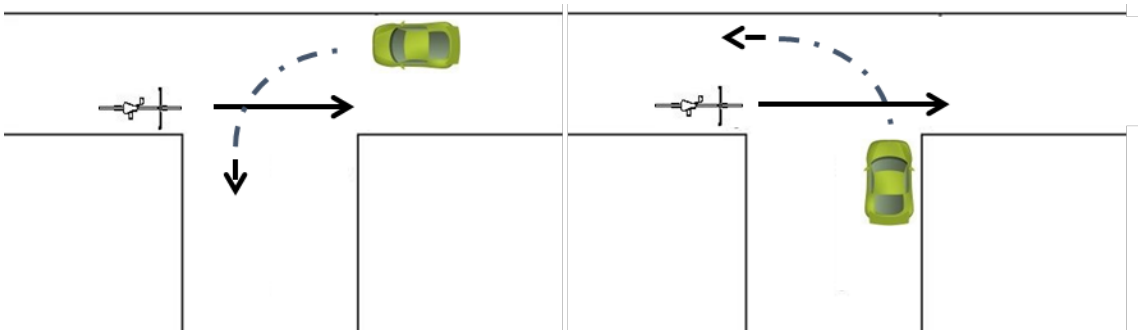
Experimental conditions

- Route profile / road gradient (flat vs. uphill)



Experimental conditions

- Observer's perspective (front view vs. side view)



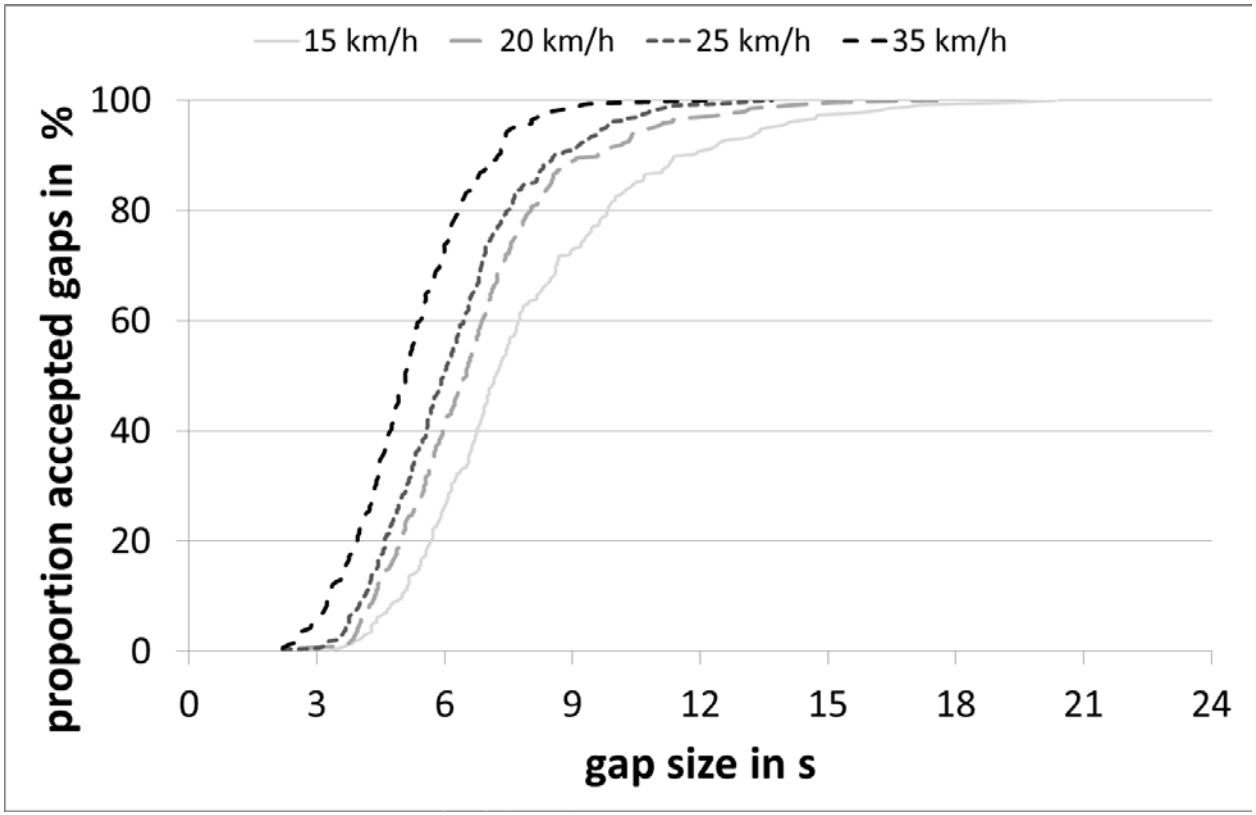
Experimental conditions

- Overview of independent variables

Age	Bicycle type	Road gradient (profile)	Observer's perspective	Speed
30-45 65 +	Conventional bike E-bike	0% 3.75%	Front view Side view	**15 km/h** **20 km/h** **25 km/h** **35 km/h (e-bike only)**

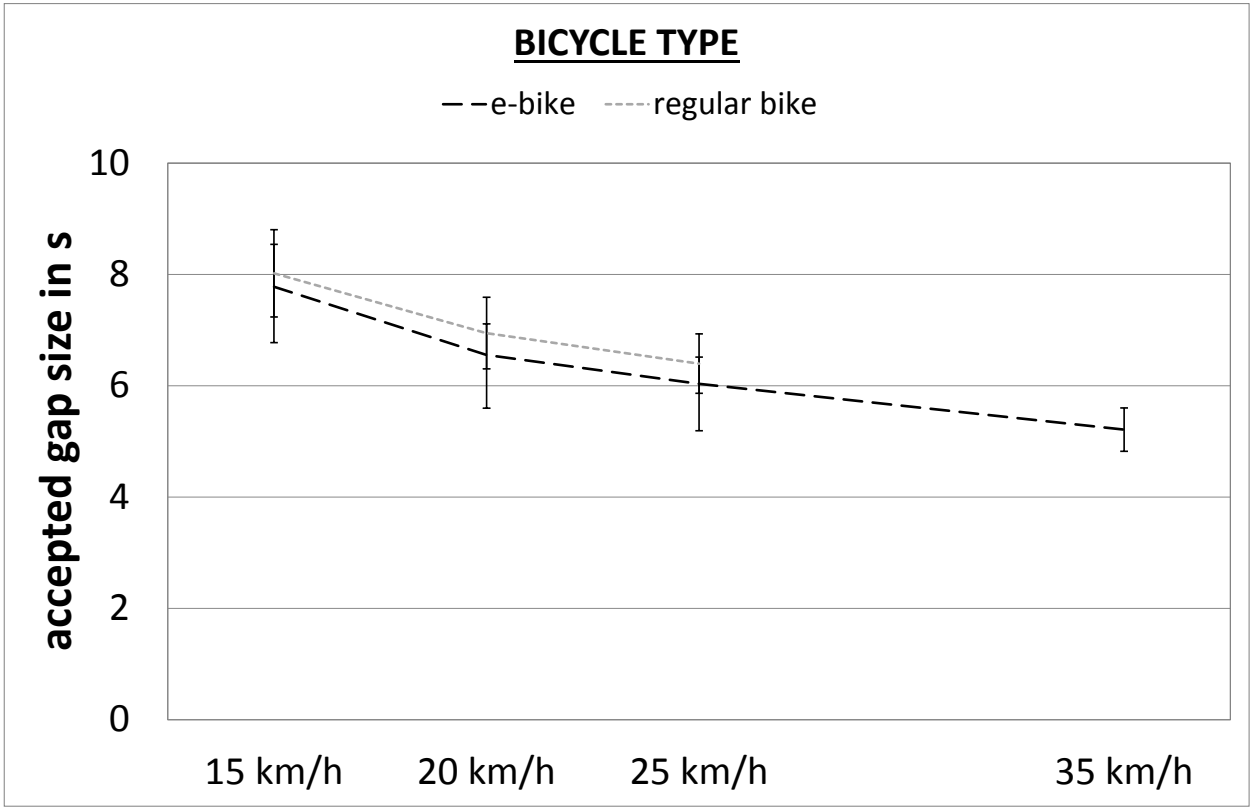
Results

- Speed
  - $F(2, 80) = 68.95$, $p < 0.001$, $\eta^2_p = .63$



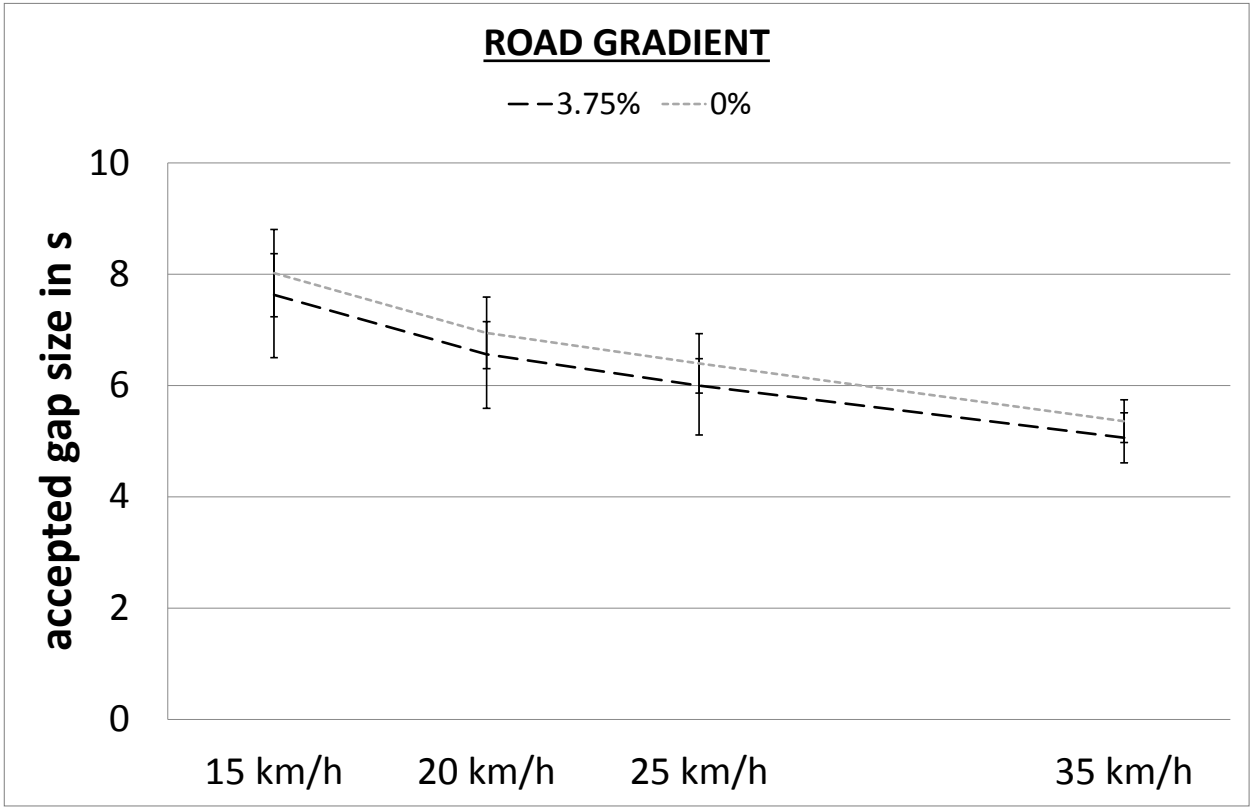
Results

- Bicycle type (x Speed)
  - $F(1, 40) = 18.41$, $p < 0.001$, $\eta^2_p = .32$



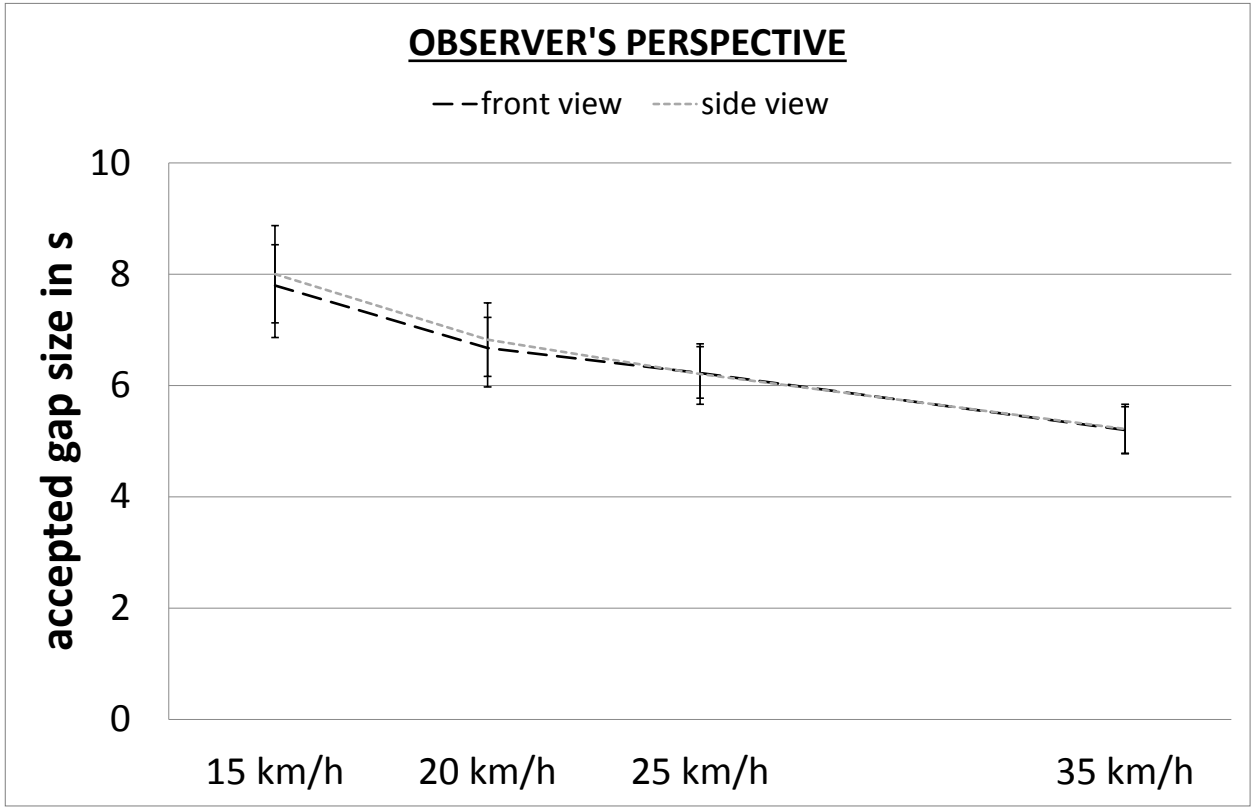
Results

- Road gradient (x Speed)
  - $F(1, 40) = 12.21$, $p = 0.001$, $\eta^2 p = .24$



Results

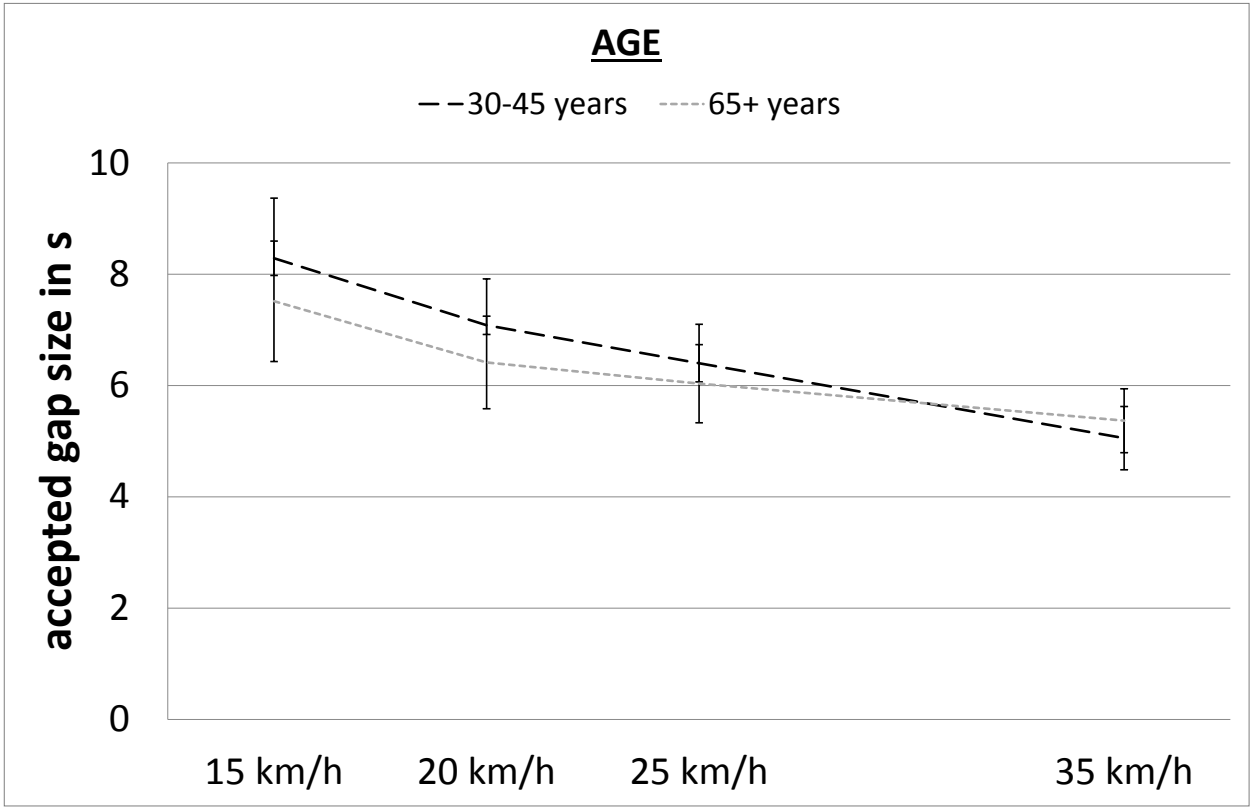
- Observer's persp. (x Speed)
  - $F(1, 40) = 0.61$, $p = 0.438$, $\eta^2_p = .02$



Results

- Age

  (x Speed)
  - $F(1, 40) = 1.02$, $p = 0.319$, $\eta^2_p = .03$

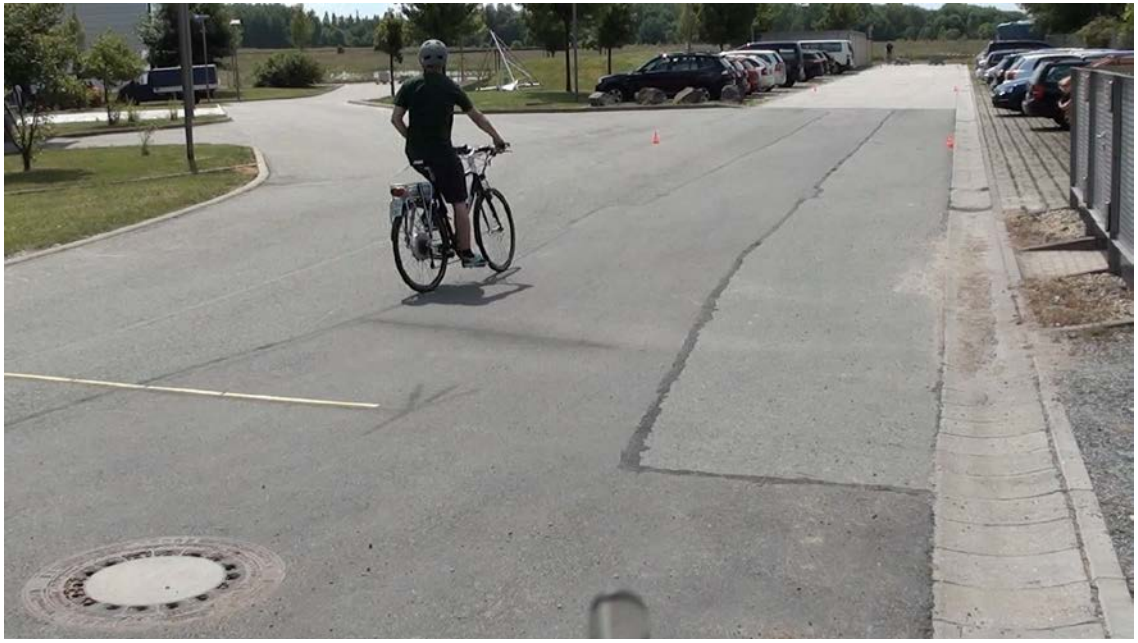


Summary & conclusions

- Higher speed → smaller gaps
  - Potential to increase crash risk?
- E-bike → smaller gaps
  - Heuristics based on riders' perceived effort?
- (uphill approach → smaller gaps)

The actual safety consequences of a growing e-bike population need to be monitored carefully.

Thank you for your attention!



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