Loughborough University

Pedestrian Interactions with Autonomous Vehicles: Exploring the Behaviour of Distracted Pedestrians

Amy O'Dell
Supervisors: Professor Andrew Morris,
Dr Ashleigh Filtness

#InspiringWinners since 1909

Presentation Outline

- Research aim/project focus
- Theoretical background and overview of literature
- Research plan
- Proposed further research

Project aim

To develop an understanding of pedestrian behaviour through systematic investigation and testing/application of theoretical psychological models to road user behaviour.

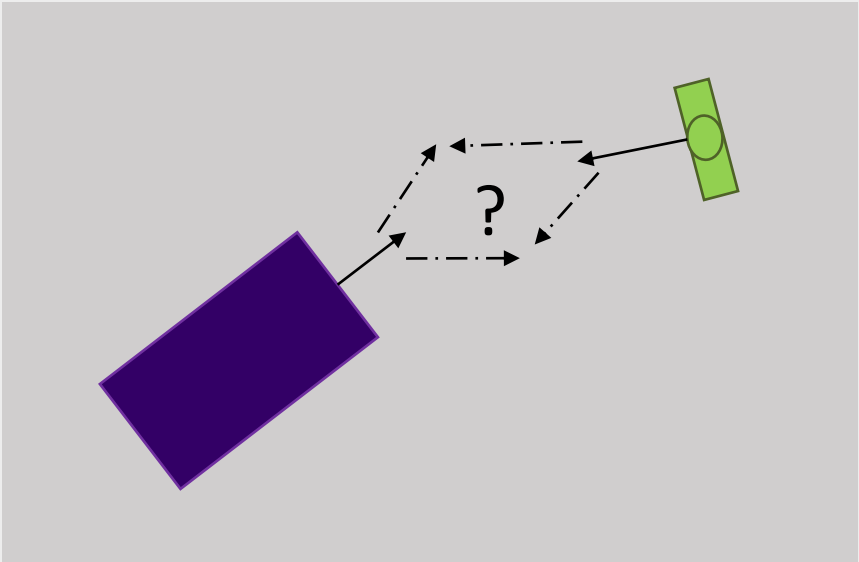
To apply these principles to AV system design guidelines with a view to improving efficiency and safety on public roads.

Pedestrians as VRUs

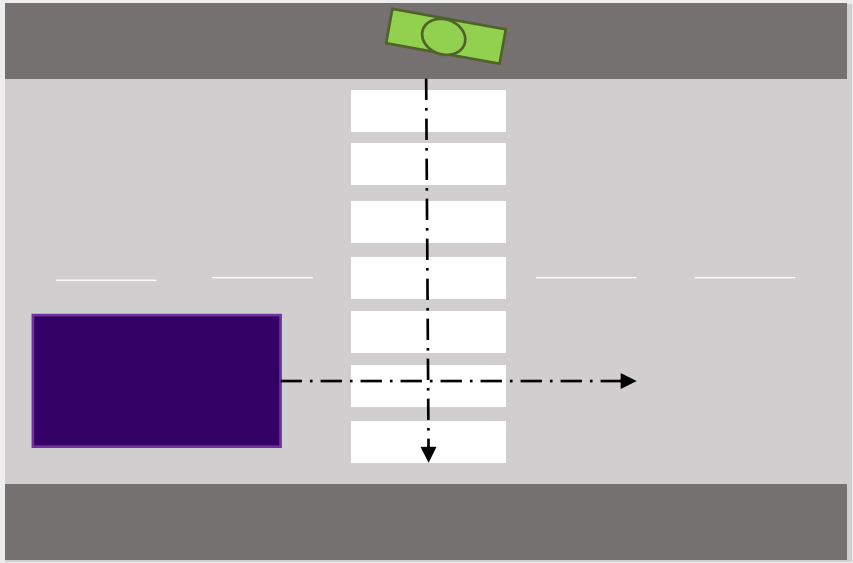
Interaction: “A situation where the behaviour of at least two road users can be interpreted as being influenced by the possibility that they are both intending to occupy the same region of space at the same time in the near future”

Markkula et al., 2020

Unconstrained head-on path



Crossing paths



Adapted from Markkula et al., 2020

Positive Psychology

"Road safety is a state of wellbeing for all road users, in which every individual can negotiate the traffic effectively, can cope with normal stresses of the traffic environment and is able to contribute to a positive traffic culture" – Kleisen, 2013

Resilience Engineering

Safety I	Safety II
- Reactive - Incident reporting, root cause analysis, guidelines etc. - Hindsight bias	- Proactive - ‘How things go right’ - Acknowledges complexity and lack of predictability

Four capacities of resilience

Ability to respond safely to problems

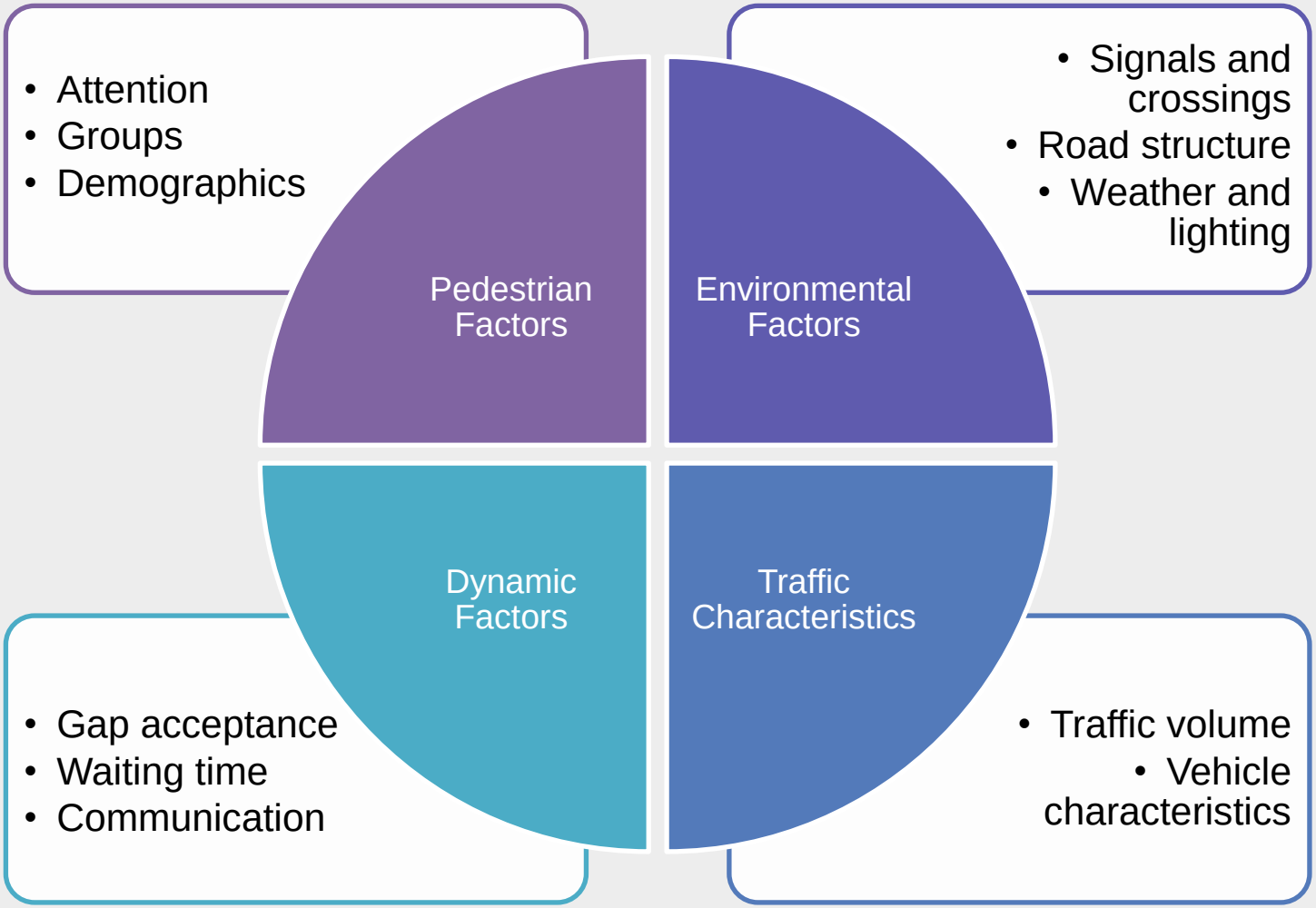
Ability to learn from experience

Ability to monitor and identify needs

Ability to anticipate future needs

Hollnagel, 2012

What do we already know about pedestrian behaviour and communication with vehicles?



Adapted from Rasouli & Tsotsos (2019)

What challenges are there for AV-Pedestrian communication?

- Ability of AV to successfully detect and react to pedestrian behavioural signals/gestures
- Ability of AV to successfully detect different types of pedestrian and respond to possible crossing interactions
- Ability of AV to react to non-compliance by pedestrians
- Pedestrian ability to detect which vehicles are AVs and react accordingly

Adapted from Parkin et al. 2016

Distracted pedestrians

Theoretical background of distraction/attention

Mindlessness theory

Perceptual load theory

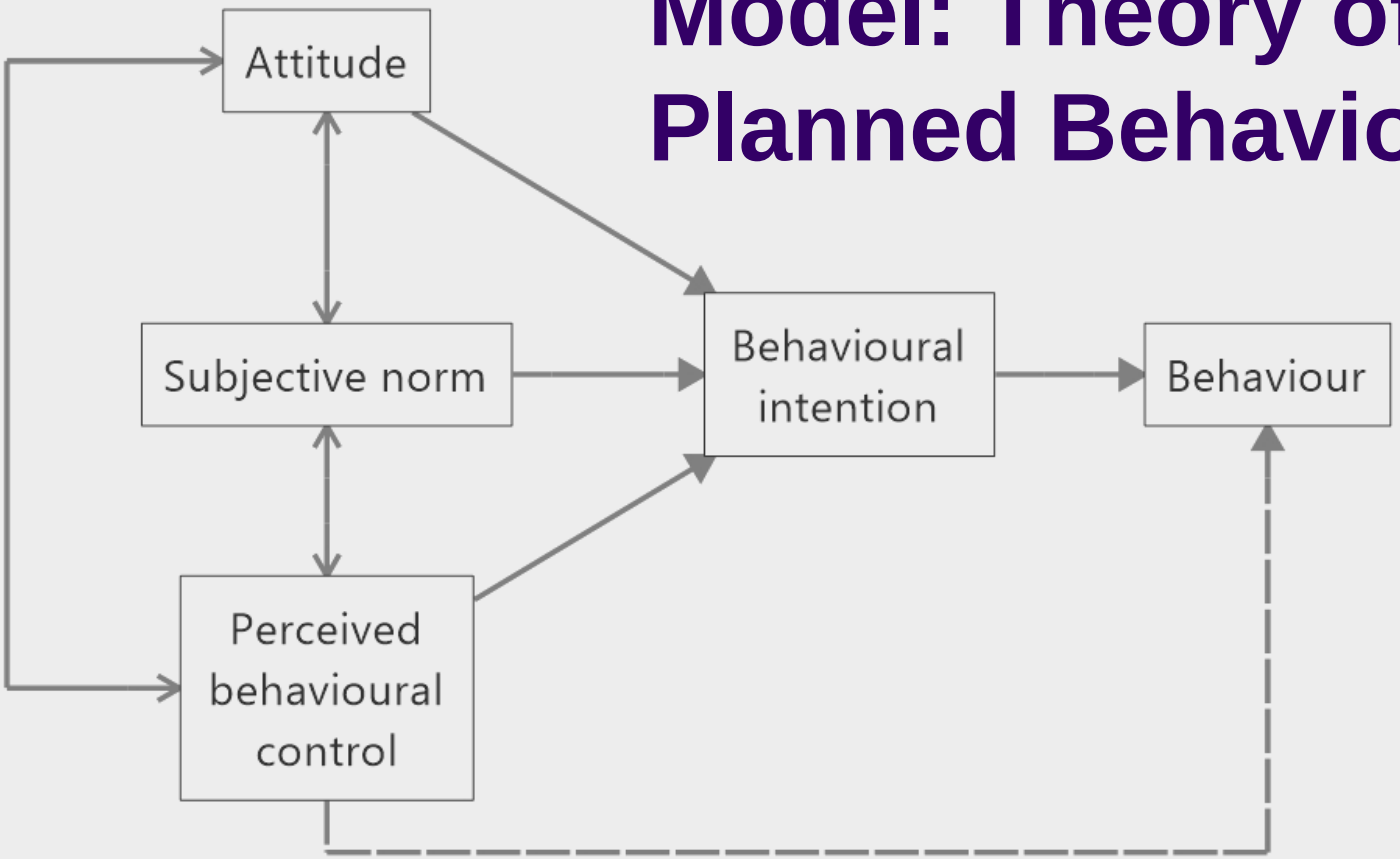
What do we know about distracted pedestrian behaviour?

- Prevalence
- Inattentional blindness
- Walking behaviour
- Crossing behaviour

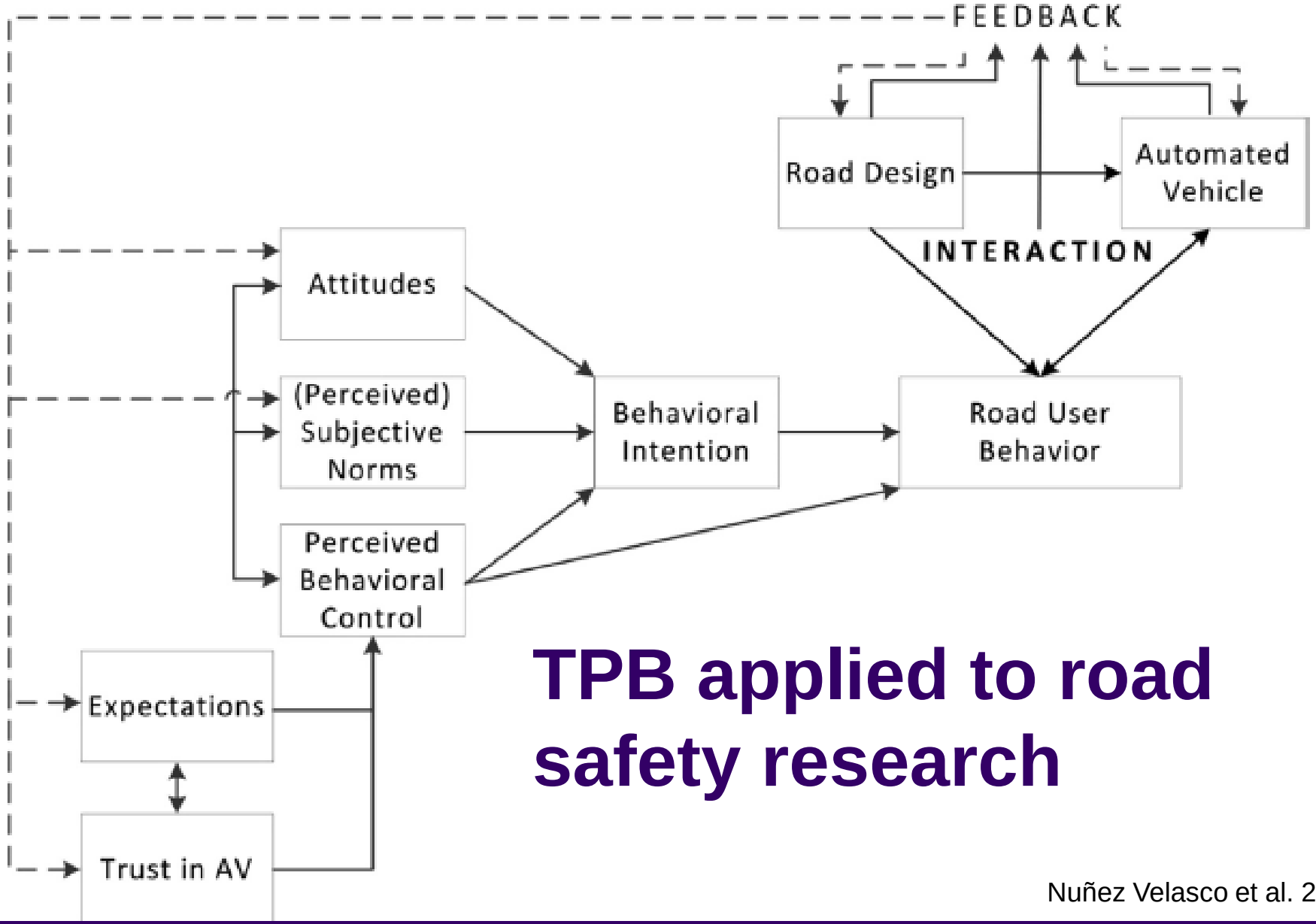
What challenges do distracted pedestrians present for AV development?

- Adapting software model
- AV ability to identify indicators of pedestrian distraction
- AV ability to react/respond to indicators of pedestrian distraction
- AV ability to deal with false positives
- AV ability to replicate successful interactions seen between vehicle drivers and pedestrians

Psychological Model: Theory of Planned Behaviour

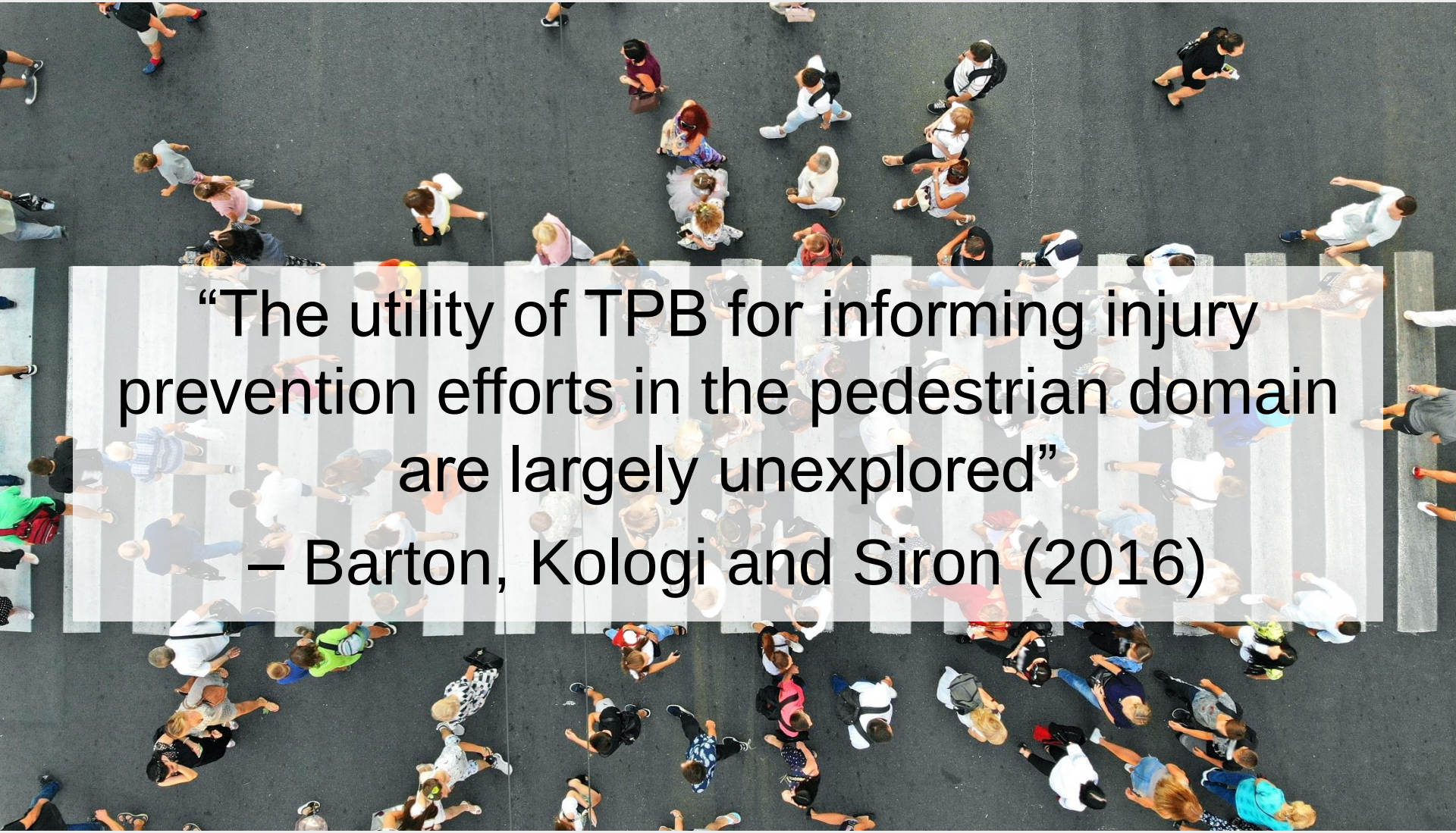


Adapted from Ajzen, 1991



TPB applied to road safety research

Nuñez Velasco et al. 2017



“The utility of TPB for informing injury prevention efforts in the pedestrian domain are largely unexplored”

– Barton, Kologi and Siron (2016)

Project research questions

- How do pedestrians behave around and interact with vehicles, and how is behaviour changed/influenced by the additional pressure of distraction?
- What behaviours are demonstrated by distracted pedestrians?

- How do distracted pedestrians behave in shared space environments containing a combination of AVs and conventional vehicles?
- Can Theory of Planned Behaviour (TPB) be used to predict the behaviour of distracted pedestrians in a shared space case study?
- How can knowledge about distracted pedestrians be used to inform AV system design guidelines?

Creating a taxonomy of distracted pedestrian behaviours

Loughborough University

#InspiringWinners since 1909

STUDY 1

To explore the pressure of distraction and its effects on crossing decisions

Pilot study

- Focus group
  - Small group session
  - Conducted using online meeting software
  - Demonstrating common pedestrian distraction scenarios
- Aim
  - To discuss issues related to distraction among pedestrians, which will inform a larger-scale survey

Focus group research questions

- How do pedestrians cross roads safely? What is the decision-making process? With the additional pressure of distraction
- What are the impacts of distracted walking?
- How do pedestrians feel about different distracted behaviours at crossing locations?
- What behaviours do pedestrian engage in when distracted and why?


15

Preliminary results

- Identified issues
  - ‘Careless’, ‘makes me feel anxious’, ‘lack of awareness’, ‘brave’
- Own approach
  - ‘Wait for a hand gesture’, ‘acknowledge the driver’, ‘put my phone down’, ‘make eye contact’
  - ‘I might have done it very similarly before so I can’t judge’


Distractions
Animals
Navigating
Loud noises
State
Supervising
Sport
Other pedestrians
Phone
Friends
Weather
Intrusive thoughts

Questions raised during discussion

- To what extent are distractions voluntary?
- When crossing while distracted, do we look but fail to see/remember?
- To what extent is walking/crossing an automatic process?
- Are all distractions equal?

Survey

- Drawing on issues raised in focus group
- Incorporation of TPB
- Larger scale
- Cognitive process
- Behaviours pedestrians engage in

STUDY 2

How does the behaviour of observably distracted pedestrians differ based on crossing type?

Aims and rationale

- Do observably distracted pedestrians behave differently when using different types of crossing?
  - Signalised/unsignalised
- Are there differences in behaviour between observably distracted and non-distracted pedestrians?

Methodology

- Discrete on-road observations
  - Urban environment
  - Popular crossing points
- Analysis of pre-existing video data
  - Validation of observation data

Compiling taxonomy

STUDY 3

To test and validate the taxonomy through systematic investigation

Testing taxonomy

- Aims
  - To apply the behaviours identified through the taxonomy in an experimental setting
  - To use TPB to predict pedestrian behaviour under conditions of distraction
- Methodology
  - Investigating crossing behaviour in a naturalistic/simulated environment

Summary table

Study	Aim	Methodology
Study 1	- To explore the pressure of distraction and its effects on crossing decisions	- Focus group - Survey
Study 2	- To assess differences in distracted behaviour at different types of crossing	- Discrete on-road observations - Analysis of pre-existing video data
Study 3	- To present a taxonomy of distracted pedestrian behaviours - To test and validate the taxonomy through systematic investigation	- Experiment in simulated environment
Further research	- To discuss design process issues and implementation of design guidelines with manufacturers	- Discussion/interview

Loughborough University

Thank you!

a.odell@lboro.ac.uk

Loughborough Design School

References

- Markkula, G. *et al.* (2020) 'Defining interactions : A conceptual framework for understanding interactive behaviour in human and automated road traffic', 2, pp. 1–29.
- Ajzen, I. (1991) 'The theory of planned behavior', *Organisational Behaviour and Human Decision Processes*, 50, pp. 179–211.
- Barton, B. K., Kologi, S. M. and Siron, A. (2016) 'Distracted pedestrians in crosswalks: An application of the Theory of Planned Behavior', *Transportation Research Part F: Traffic Psychology and Behaviour*. Elsevier Ltd, 37, pp. 129–137.
- Velasco, N. and Arem, V. (2017) 'Interactions between vulnerable road users and automated vehicles : A synthesis of literature and framework for future research', *Road Safety and Simulation International Conference*, pp. 1–12.
- Kleisen, L. M. B. (2013) 'A positive view on road safety: Can "car karma" contribute to safe driving styles?', *Accident Analysis and Prevention*. Elsevier Ltd, 50, pp. 705–712.
- Hollnagel, E. (2014) *Safety-I and Safety-II: The past and future of safety management*. Farnham. Ashgate Publishing, Ltd.
- Parkin, J., Clark, B., Clayton, W., Ricci, M. and Parkhurst, G. (2016) *Understanding interactions between autonomous vehicles and other road users: A Literature Review*. Project Report. University of the West of England, Bristol. Available from: http://eprints.uwe.ac.uk/29153