‘Exploring the road safety benefits of direct vision’

Transport for London, Arup & The University of Leeds PAC Lab

Project Purpose & Aims

- Provide empirical research to address a research-gap around understanding the potential benefits of seeing vulnerable road users directly as opposed to indirectly i.e. through mirrors
- Improve understanding of visual processing of information in a driving context
- Establish the extent to which increased direct vision could reduce driver reaction times
- Reduce the number of near misses and collisions between HGVs and vulnerable road users

Number of HGV collision related KSIs – **5123**

Number of experiments investigating direct vision in a dynamic setting – **0**

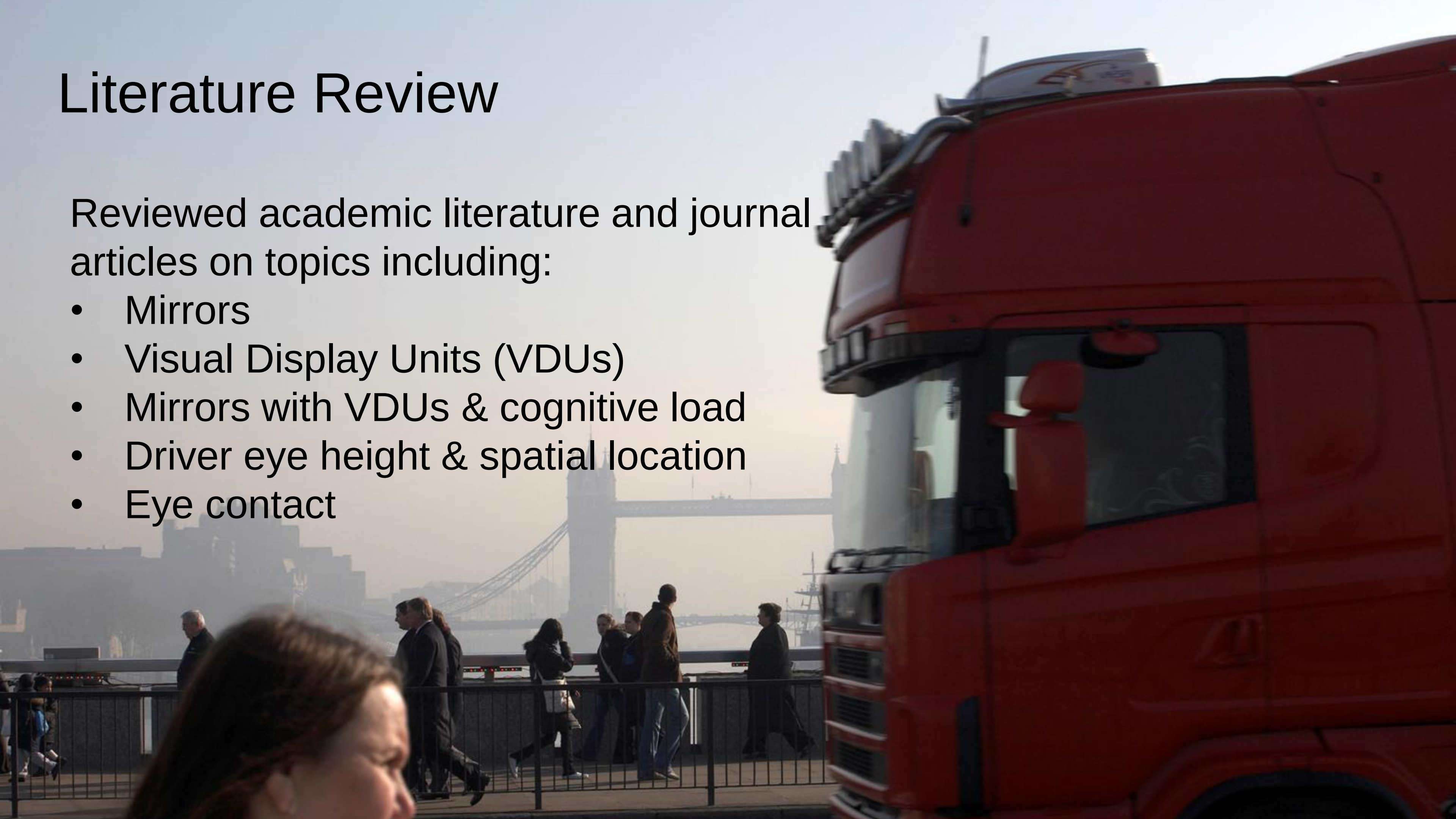
Project Progress

Completed:

- Literature review
- Survey
- Laboratory experiments phase I and phase II

Ongoing:

- Experiment data analysis
- Cost benefit analysis & peer review
- Cost to industry



Literature Review

Reviewed academic literature and journal articles on topics including:

- Mirrors
- Visual Display Units (VDUs)
- Mirrors with VDUs & cognitive load
- Driver eye height & spatial location
- Eye contact

Mirrors

Mirrors provide useful visual information of the scene not directly visible to drivers.
However, there are risks:

- Mirrors can distort reflected objects
- Reflected objects tend to be overlooked in comparison to direct objects
- Recognition rates are compromised towards mirror edges
- Mirrors may be set up incorrectly, impairing coverage
- View can be influenced by elements such as rain and dirt

Visual Display Units (VDUs)

VDUs are intended to extend a HGV driver's visual field and aid decision making.

Current research suggests a number of risks related to glancing at VDUs when driving:

- Increased periods of off-road glances
- Drivers take longer to acquire critical information when returning gaze to the road
- Image resolution sensitive to environmental conditions
- Limited resolution and colour range, minimal time-delay

Cognitive Load

Indirect vision through mirrors & VDUs increases cognitive load through increased visual processing demands.
Put simply; it's hard to think about lots of things at once.
This can result in impaired driving performance:

- Reduced hazard detection
- Abrupt steering wheel movements
- Impaired lane-keeping

Driver Eye Height & Spatial Location

Limited previous research into eye-height, and particularly spatial location of visual information i.e. VDUs. However, findings suggest:

Driver Eye-Height

Increases detection of VRUs close to the vehicle

Provides larger field of view

Spatial Location

Lack of research

Thorough training required

Different adaption between drivers

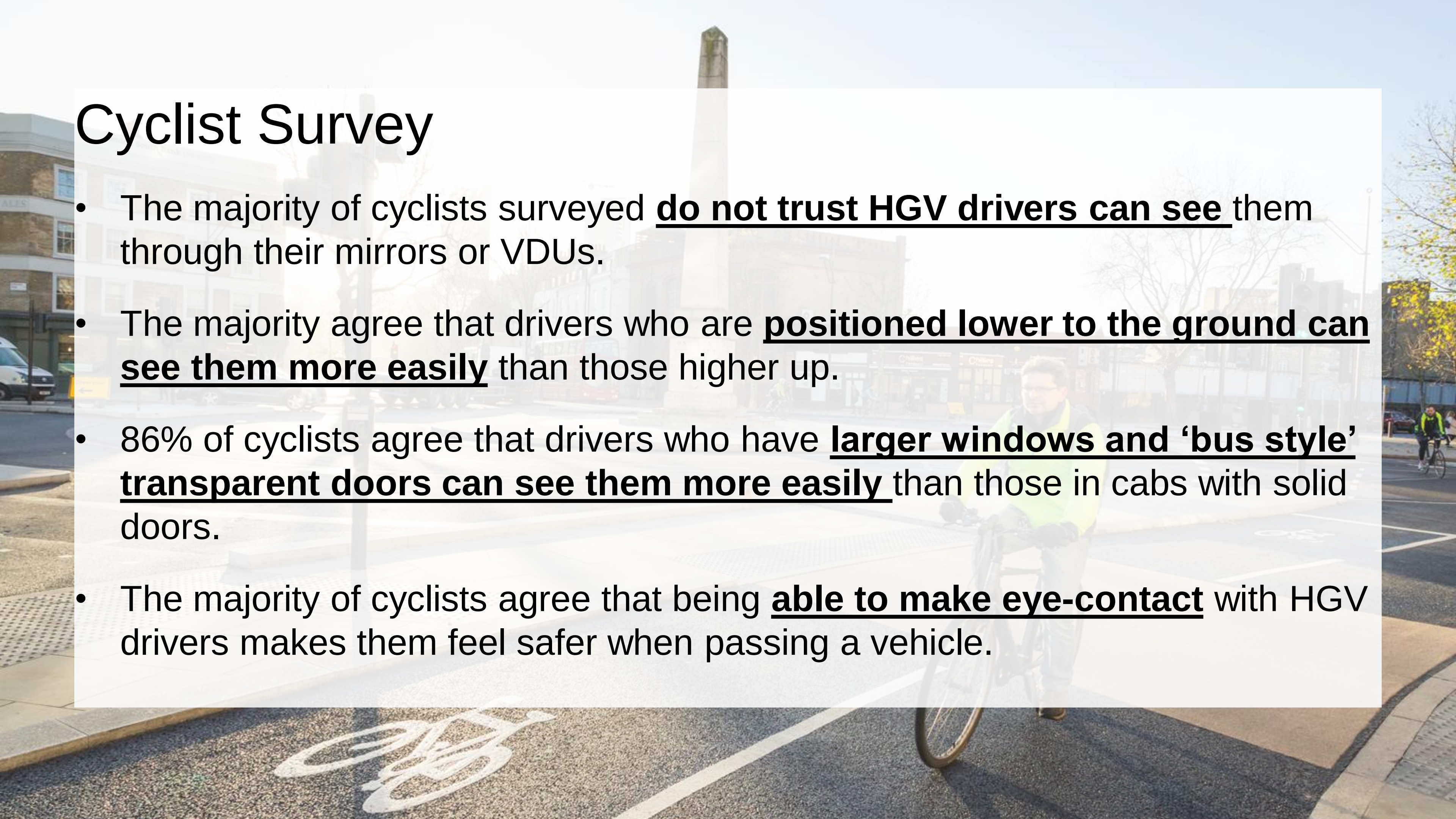
Eye Contact w/ VRUs

There is little literature exploring the impact of eye contact between VRUs and drivers.
There is agreement that drivers attention is naturally drawn to VRUs faces.
However, conflicting findings exist around the benefits of this:

Arm signals and informal glances slowed driver’s safety related decision making to VRUs

Other research suggests positive implications for eye-contact between pedestrians and drivers such as reduced speed and increased stopping

Survey Key Findings



Cyclist Survey

- The majority of cyclists surveyed **<u>do not trust HGV drivers can see</u>** them through their mirrors or VDUs.
- The majority agree that drivers who are **<u>positioned lower to the ground can see them more easily</u>** than those higher up.
- 86% of cyclists agree that drivers who have **<u>larger windows and ‘bus style’ transparent doors can see them more easily</u>** than those in cabs with solid doors.
- The majority of cyclists agree that being **<u>able to make eye-contact</u>** with HGV drivers makes them feel safer when passing a vehicle.

Pedestrian Survey

- As with cyclists, pedestrians surveyed do not trust that HGV drivers can **see them through their mirrors or VDUs**.
- Majority agree that **lower cab height** and **larger windows** are safer.
- The majority of cyclists agree that being able to **make eye-contact** with HGV drivers makes them feel safer when passing a vehicle.

HGV Drivers Survey

The majority of HGV Drivers surveyed agree that:

- **Mirrors provide sufficient view** of cyclists and pedestrians around the vehicle. However almost half felt that it is **sometimes difficult to recognise a cyclist** in a mirror.
- Most drivers perceive **more advantages than disadvantages** of VDU use.
- Majority **disagree that they are too high up** to locate road users.
- 41% of drivers agree that **increasing the size of windows** would support them to avoid collisions with vulnerable road users.
- Most drivers **try to make eye-contact** with road users and believe this reduces likelihood of collision.

Laboratory Experiments

Experiment 1

- 1.1 Navigating around an environment containing VRUs when driving:
  - Traditional cab
  - Low entry cab
- 1.2 Reaction to visual subjects seen:
  - Directly (through a windscreen)
  - Indirectly (through a mirror)

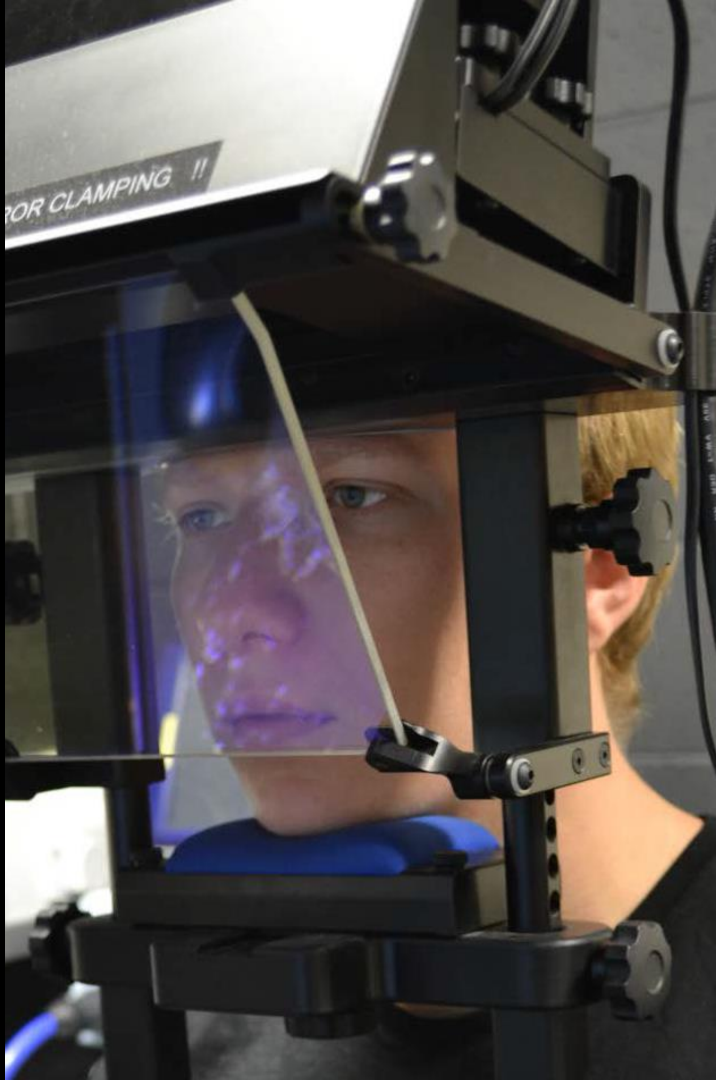
Experiment 2

Adding a cognitive distraction task to Experiment 1

Task: Refer to visual display unit, respond when numbers presented are odd

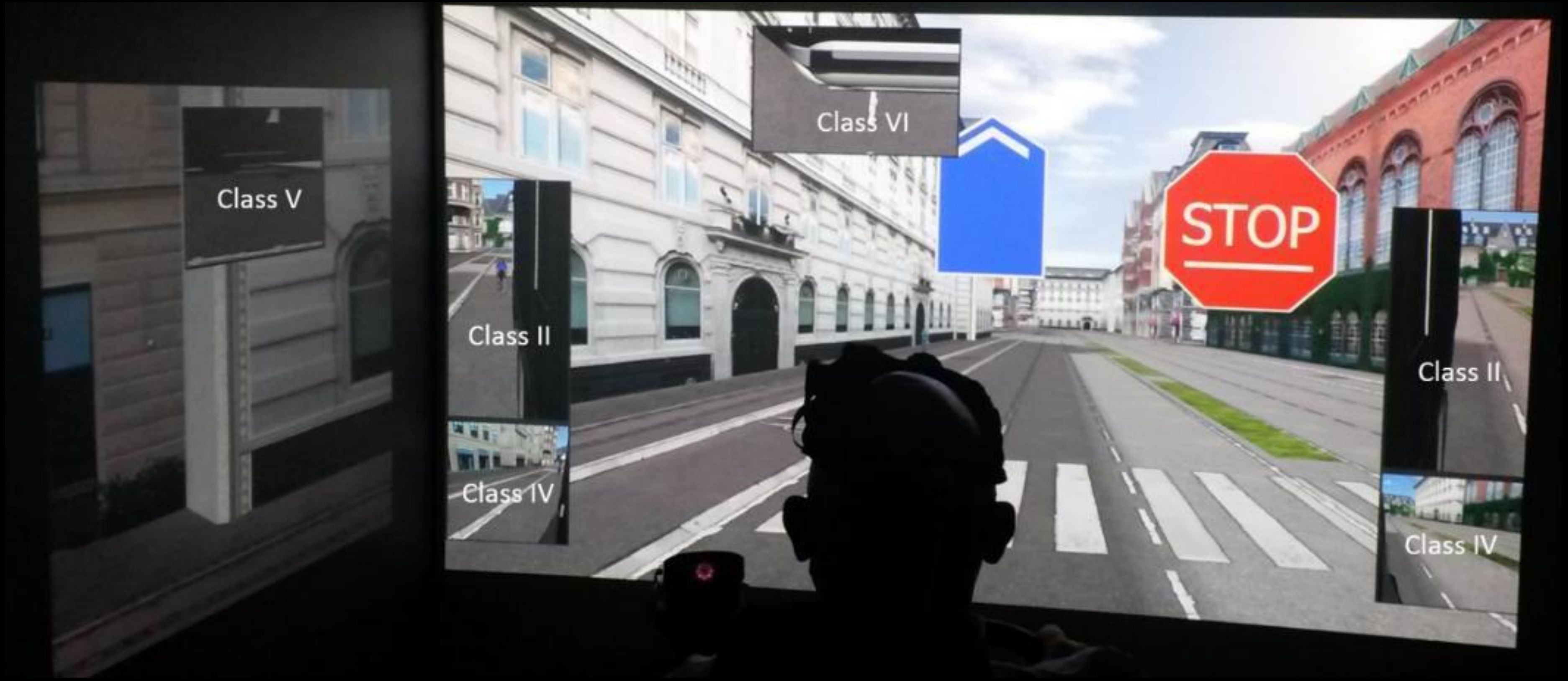
Participants:

- 11 professional HGV drivers (Exp 1)
- 60 non-professional drivers (30 Exp 1; 30 Exp 2)



Lab Set-up: Simulated driving environment

Lab Set-up: Mirror positioning



Lab Set-up: Traditional vs. Low Entry Cab

	Traditional Cab	Low Entry Cab
Eye Height	2.5m	2m
Side Door	40% occlusion	Glass side door
Front Blind Spot Size	0.69m	0.0m
Side Blind Spot Size	1.3m	0.0m
Front Window Size	0.9m x 1.67m	0.9m x 1.67m
Side Window Size	0.66m x 0.8m	1.1m x 0.8m

Example of the view of the same stimulated driving environment in the:

A. Traditional Cab
B. Low Entry Cab

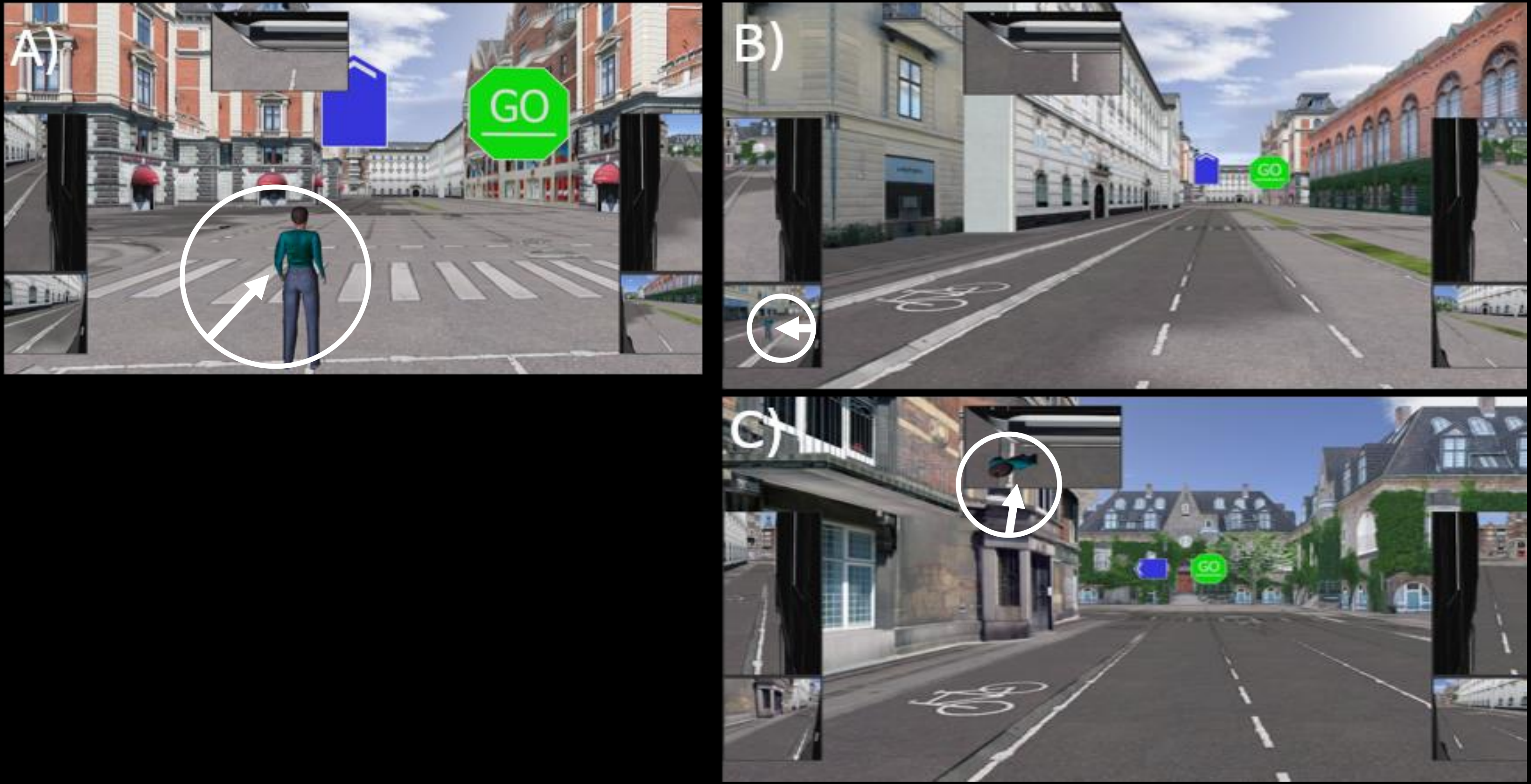
A

B

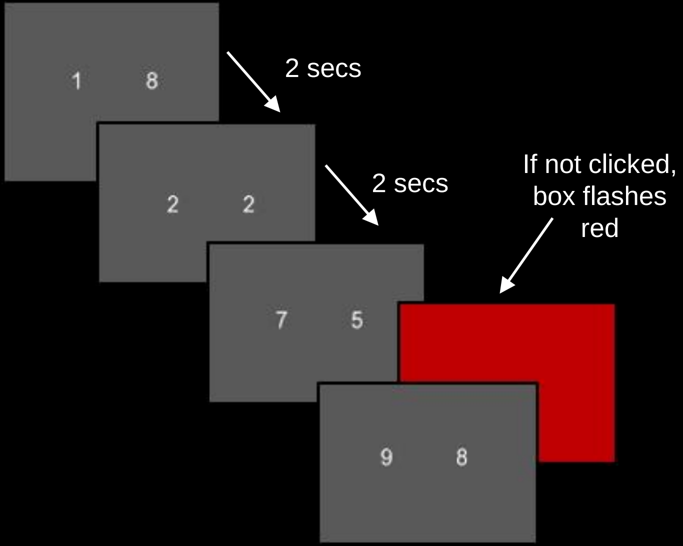
Experiment 1: VRU Interaction Experiment

Experiment 1: Hi and Low Visibility Object Search

Experiment 2: Pedestrian Subject Search

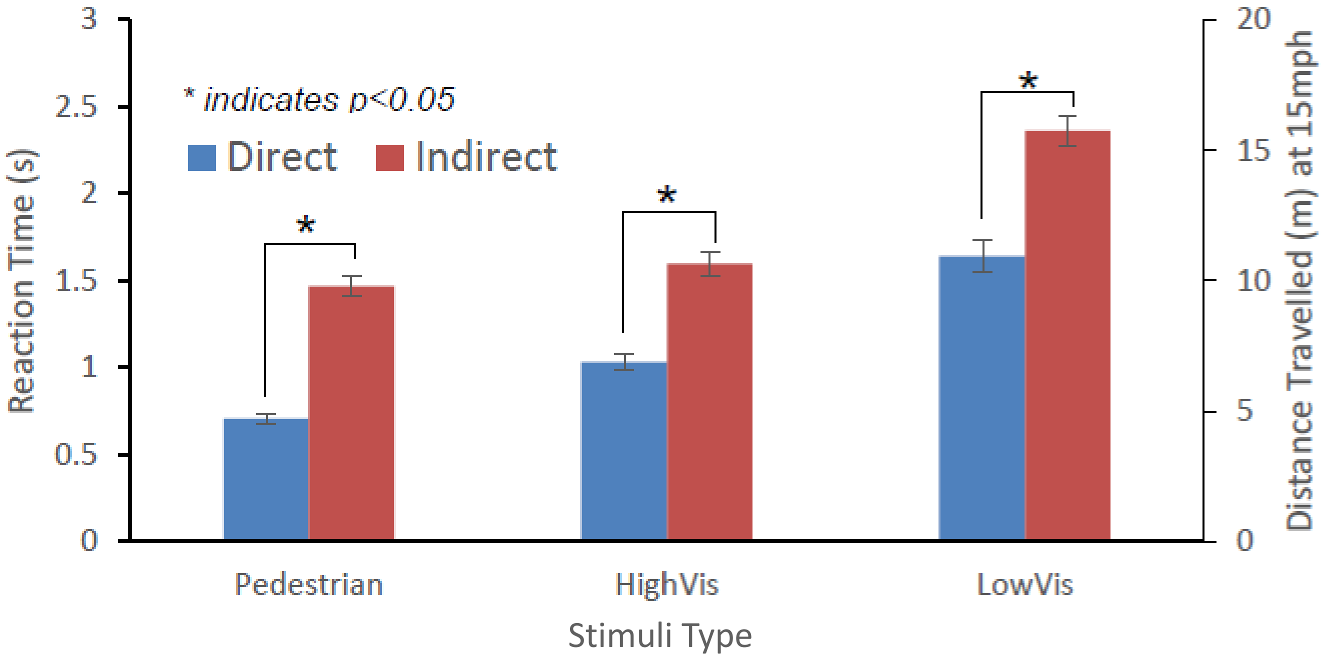


Experiment 2: Distraction Task



Experiment 1: Subject Search Results

The results showed that **direct vision responses were on average 0.7s faster** than indirect (through mirrors). When responding to pedestrians, viewing indirectly doubled the response time.



Experiment 1: Results Applied

Even at slow (15mph) driving speeds this would cause 4.7m of extra travel before braking, more than enough to collide with a proximal pedestrian.

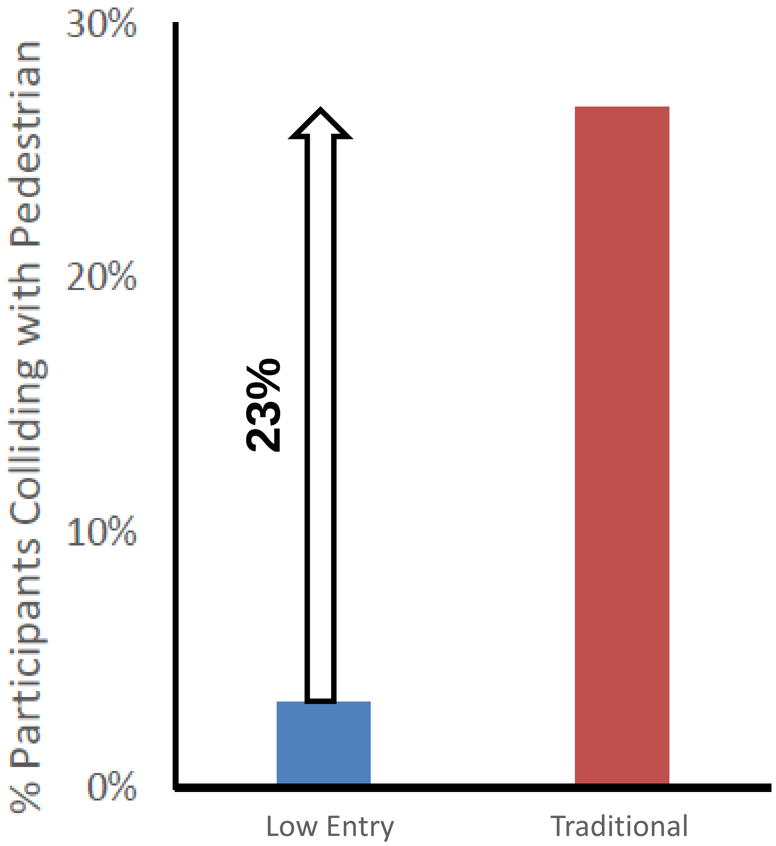
At a 5 mph pulling off speed, this still equates to 1.5m extra travel.

Speed	Extra Travel
15 mph	4.7 m
10 mph	3.1 m
5 mph	1.5 m

Experiment 1: VRU Interaction Results

We ran a second experiment with pedestrians walking in front of the vehicle to assess if slower reaction times led to more collisions.

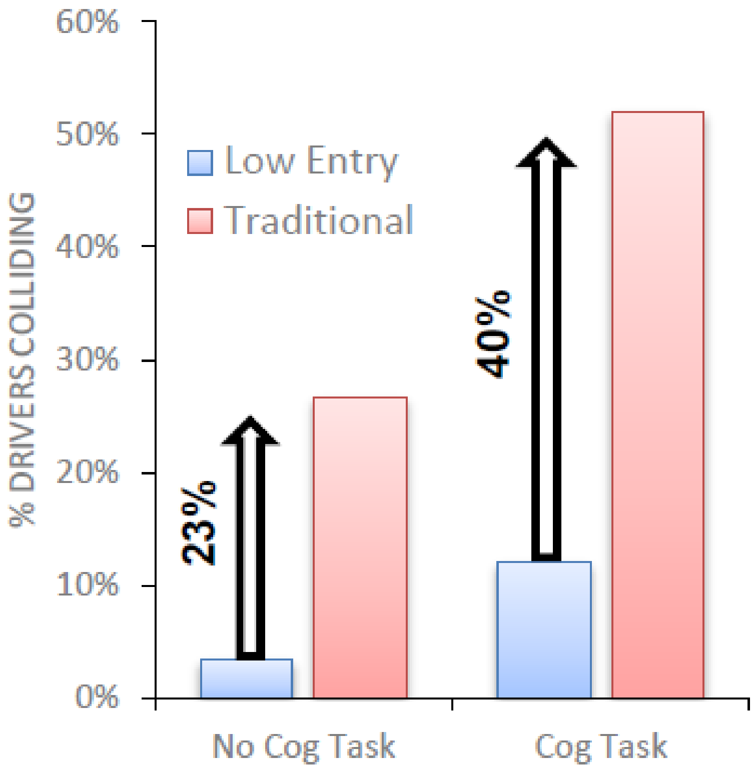
Driving a traditional cab resulted in a 23% increase in pedestrian collisions. Statistical analysis confirmed that the difference was significant.



Experiment 2: Results

As the cognitive task at hand gets increasingly difficult, the ability to directly view a pedestrian becomes increasingly important.

The number of drivers colliding with *at least* one pedestrian when **driving** <u>and</u> **processing a cognitive task** was **40% higher when driving the traditional HGV cab as opposed to the low entry cab.**



Implications of findings