CASE STUDY

Making Roads Safer

Overview

This is the account of a partnership, between industry and academia, that applied Business Psychology to save lives!

Together they conducted innovative research into driving behaviour and the design of heavy goods vehicle (HGV) cabs. Their objective was to improve the working environment of drivers and the safety of vulnerable road users (VRUs). The results of this research led to regulatory changes in HGV design across the continent.

Challenge

Europe’s population continues to increase, and with this comes the demand for more goods, more services, more homes and better infrastructure. As cities like London see continuous construction, and with next day deliveries more commonplace, roads have become increasingly congested.

About 4.000 people died in road accidents involving HGVs in 2016. (Source: European Road Safety Observatory, Traffic Safety Basic Facts 2018.) Yet no interventions had successfully addressed this issue or made significant improvements to road safety. With more people and more HGVs on the roads, the risk of collisions could continue to increase.

Transport for London (TfL) commissioned Arup and the University of Leeds (UoL) to conduct research – to determine the relationship between HGV cab design, driver’s cognitive reactions and collisions with VRUs – with the aim of reducing the number of people killed and seriously injured in road accidents involving HGVs. Arup and UoL partnered as Consultants on this investigation.

This investigation required a sound understanding, and means of measuring, cognition and behaviour. Business Psychology expertise were ideally suited to the challenge, and to achieving the aims of the project. Specifically, to:

- Understand how the view of a VRU affects reaction time and collision rates
- Produce impartial psychological insights with scientifically rigorous evidence
- Inform the design of a safe and user-friendly workplace for drivers

For the psychological aspects of the project to be a success, the Consultants needed to:

- Define the key research questions
- Conduct a focused in-depth literature review to establish previously conducted relevant research, and understand any previous attempts to address this challenge
- Design surveys, collecting qualitative and quantitative views from HGV drivers, pedestrians and cyclists
- Design experiments with clearly defined variables and controls
- Engage and communicate findings in a clear way

Approach

Objectives Set

TfL's definition of a successful project required that all research and findings were:

- On-time, in accordance with EU Commission timeframes
- Thorough, exhaustive and defensible on the EU stage
- Impartial and unbiased in their implications and reporting
- Reported in an accessible manner to support decision makers

Stakeholder Engagement

The stakeholder engagement elements of this project were extremely challenging. Well over 50 organisations and groups were identified as stakeholders, including manufacturers, agencies, policy makers, regulators and many more, across Europe. Whilst no one would argue against trying to reduce road deaths, the research had the potential to produce findings with significant implications for industry. For example, if the research found there was a need for new HGV design, new vehicles would need to be designed, produced and purchased. This could have huge financial impacts for both manufacturers and users, from large companies to small family operated fleets.

As the team believed this to be the first study of its kind in Europe, and a complex psychology project, the Consultants addressed diverse stakeholders and the need to make each stage of the project easy to understand. To ensure their approach was collaborative and consultative, the Consultants undertook a stakeholder mapping exercise to detail whom they needed to engage with at every stage of the project. Then they continually shared their progress and findings with the industry, gathering feedback and criticism which they used to improve their research. Their stakeholder engagement included:

- Face-to-face meetings with their main TfL stakeholders
- Sharing findings, at each stage of research, at conferences and events, being open to debate
- Organising a visit to the UoL laboratory to help stakeholders understand the methodology being used, to bring the research to life

Defining the Research Questions

The Consultants agreed to direct their research to address three questions:

- Is there a difference between driver reaction times to VRUs appearing 'directly' (through windows) versus 'indirectly' (in mirrors)?
- Is there a difference in driver behaviour in relation to VRUs when driving a traditional HGV cab versus a low-entry HGV cab?
- Is there an impact, from additional cognitive processing, on reaction times and driving behaviour?

Literature Review

The Consultants conducted a focused in-depth literature review to inform their approach. They identified both relevant existing research that could be used and research gaps that may be filled by their work.

They elected to apply an existing theory to the experimental design, that of Richard Wilkie and John Wann. Wilkie and Wann had examined the role of active gaze in shaping locomotor trajectories and published various papers. These addressed the observation, “you go where you look.” (Wilkie & Wann, 2010.)

Additional relevant research was applied, referenced in design of the laboratory experiments.

Research Survey

The Consultants conducted tailored surveys to capture perceptions of key stakeholder groups (HGV drivers, cyclists and pedestrians) in relation to HGV design (n=350).

Laboratory Experiments

With the workplace being an HGV, studying behaviour ‘at work’ was complex and posed challenges. So, Laboratory Experiments were conducted with volunteers (n=71).

The first experiment explored the psychological impacts of seeing stimuli ‘directly’ versus ‘indirectly’ (e.g. through glass versus in mirrors). A detailed literature review revealed that there are a number of risks in relying on mirrors when driving, including:

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

(Cook, et al., 2011. Delmonte, et al., 2012. Sareen, et al., 2015)

The simulated driving environment included two types of HGV cab design: traditional and low-entry. The low-entry design increased the driver’s ‘direct’ vision through a larger side window, and a lower eye-height. The team tested both regular drivers and professional HGV drivers, to compare typical human reactions to the behaviour of ‘experts.’ The experiments tested Participants in two areas:

- Navigating a virtual driving environment, experiencing at least five VRU interactions
- Adding a cognitive load (distractor task) to understand how this impacted reaction times and interactions with VRUs

In the second experiment, the Consultants used research on working memory and cognitive load. (Baddeley & Hitch, 1974. Sweller, 1998.) This research suggested that working memory is a limited-capacity system. Specifically, cognitive load is a function of the proportion of time during which an activity captures attention, impeding other processes (Barrouillet, Portrat, Vergauwe & Camos, 2007). In this context the Consultants’ second experiment assessed the impact of cognitive distractions on drivers.

Outcome

Crucial findings were:

- Looking straight through a window and directly viewing a pedestrian resulted in a 0.7 second quicker reaction time

- A driver travelling at 15mph (London average 14.6mph) needs an extra 4.7m to stop when viewing a pedestrian indirectly (equivalent to the length of an average family car), enough to cause a fatality
- When a cognitive load was added (simulating everyday driver distractions), collisions with a simulated pedestrian or cyclist were 40% lower in a low-entry cab

These findings collectively have strong implications for HGV drivers, employers and society. Drivers can experience increased demands on their cognitive processing throughout their working day. Rush hour driving requires the navigation of busy roads, and night-time driving will likely lead to mental compensation to navigate safely despite reduced visibility.

Given the ever-increasing preference of manufacturers, employers and HGV drivers for installation of technology into vehicles, it is arguable that cognitive load will increase in coming years. This research implies that these additions increase the likelihood of collisions due to impaired reaction times. It may not be possible or desirable to prevent technology being added to HGVs, but the potentially lethal consequence could be mitigated through HGV cab re-design and enhanced direct vision.

Objectives Met

For practical purposes, the Consultants further evaluated the project's success against the original aims for the work. Each of TfL's expectations were achieved. Listed below are the original requirements and actions taken in response to address the requirement.

- On-time submission of all deliverables in accordance with EU Commission timeframes
    - Rigorous project management and weekly check-ins against the project plan
- All research and findings were impartial and unbiased in their implications and reporting
    - Proposed a revised scope of work and research focus, making it broader than TfL's initial specification
- The research and findings were thorough, exhaustive and defensible on the EU stage
    - Included control experiments
    - Used professional and non-professional drivers to ensure results were not attributable to driver experience
    - Modelled virtual reality cabs on real world cab measurements, averaging across models to ensure applicability to multiple models
    - Findings shared intermittently with stakeholders to address criticisms and gaps in the approach
- The research and evidence were reported in an accessible manner to support decision makers
    - Converted the academic report into a full public report, using stakeholder language and a summary report to enable anyone to quickly understand the project and its implications

As a result of this project:

- TfL published the world's first Direct Vision Standard consultation for HGVs, directly informed by this research. It proposed a star-rating for HGVs so that those allowing only poor visibility would eventually be banned from central London

- The research gap on this topic has started to be filled, with findings published online, and written up for a peer reviewed journal
- The European Commission used the findings to inform their regulatory changes to the design of HGV cabs

Limitations of the Findings

While these findings are significant and could be used to improve road safety, it is important to take a critical view on the research. It could be argued that the collisions occurring within the driving simulator cannot be likened to real life scenarios due to the high prevalence of VRU interactions. If the team had set-up their experiment to mimic real-world VRU and HGV interaction, there would have been a low probability of participants experiencing a collision. However, the Consultants would not have been able to tell if there were any differences between the vision conditions because both scores would have been low or non-existent (a phenomenon called floor effects). It was therefore an experimental necessity to force drivers into potentially hazardous VRU interactions, to examine the implications of 'direct' versus 'indirect' vision on driver response.

VRU behaviour has also been shown to cause accidents. For example, 'failing to look properly' has been attributed to cyclists in 43% of serious collisions at junctions. This suggests that while dangerous VRU behaviour may not be as prevalent as simulated in the research, it does still contribute to accidents.

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