Applied Ergonomics 68 (2018) 213–228

Contents lists available at ScienceDirect

Applied Ergonomics

journal homepage: www.elsevier.com/locate/apergo

Creating the environment for driver distraction: A thematic framework of sociotechnical factors

Katie J. Parnell*, Neville A. Stanton, Katherine L. Plant

Transportation Research Group, Faculty of Engineering and the Environment, Boldrewood Innovation Campus, University of Southampton, Burgess Road, Southampton, SO16 7QF, United Kingdom

ARTICLE INFO

Keywords:
In-vehicle technology
Driver distraction
Qualitative methods
Sociotechnical systems

ABSTRACT

As modern society becomes more reliant on technology, its use within the vehicle is becoming a concern for road safety due to both portable and built-in devices offering sources of distraction. While the effects of distracting technologies are well documented, little is known about the causal factors that lead to the drivers' engagement with technological devices. The relevance of the sociotechnical system within which the behaviour occurs requires further research. This paper presents two experiments, the first aims to assess the drivers self-reported decision to engage with technological tasks while driving and their reasoning for doing so with respect to the wider sociotechnical system. This utilised a semi-structured interview method, conducted with 30 drivers to initiate a discussion on their likelihood of engaging with 22 different tasks across 7 different road types. Inductive thematic analysis provided a hierarchical thematic framework that detailed the self-reported causal factors that influence the drivers' use of technology whilst driving. The second experiment assessed the relevance of the hierarchical framework to a model of distraction that was established from within the literature on the drivers use of distracting technologies while driving. The findings provide validation for some relationships studied in the literature, as well as providing insights into relationships that require further study. The role of the sociotechnical system in the engagement of distractions while driving is highlighted, with the causal factors reported by drivers suggesting the importance of considering the wider system within which the behaviour is occurring and how it may be creating the conditions for distraction to occur. This supports previous claims made within the literature based model. Recommendations are proposed that encourage a movement away from individual focused countermeasures towards systemic actors.

1. Introduction

Technological developments are largely driven by industrial or commercial requirements which, Dorf (2001) claims, are harnessed by mankind to change or manipulate their environment. The driving environment has changed markedly through the implementation of technology over recent decades (Walker et al., 2001). This has had ramifications for the design and use of vehicles (Wierwille, 1993; Walker et al., 2001). Drivers now expect the design of the vehicle to include technological facilities that enable entertainment, navigation, communication, connectivity, efficiency and comfort while driving. Yet, there is a need to ensure that the implementation of such technologies does not adversely affect road safety (Lee et al., 2008; Young et al., 2011).

The distractive effects of hand-held phones have been evidenced, with adverse consequences to driver performance metrics, such as vehicle control (Tsimhoni et al., 2004), attention tunnelling (Reimer, 2009), and hazard detection (Summala et al., 1998) among others. Yet, despite being made aware of the risks posed by mobile phones while driving and legislation to ban their use across many countries, drivers continue to engage with them (Dingus et al., 2006; Lerner et al., 2008; Walsh et al., 2008; Zhou et al., 2012; Young and Lenné, 2010; Metz et al., 2015; Tivesten and Dozza, 2015). While previous research has informed on the adverse consequences of mobile phones, the contextual and motivational factors that lead to engagement in other technological tasks is under-researched (Young and Regan, 2007; Young et al., 2008; Young and Lenné, 2010; Tivesten and Dozza, 2015; Horrey et al., 2017).

Some research has been conducted into the decisions that drivers make to engage with distractions in simulators (Metz et al., 2011; Schömig and Metz, 2013), on test tracks (Horrey and Lesch, 2009) and through the analysis of data derived from naturalistic studies (Metz et al., 2015; Tivesten and Dozza, 2015). A challenge in the assessment of driver distraction research is the dichotomy between high levels of

* Corresponding author.
E-mail addresses: kp4g13@soton.ac.uk (K.J. Parnell), N.stanton@soton.ac.uk (N.A. Stanton), K.plant@soton.ac.uk (K.L. Plant).

https://doi.org/10.1016/j.apergo.2017.11.014
Received 2 August 2017; Received in revised form 27 October 2017; Accepted 27 November 2017

control and the naturalistic study of behaviour (Young et al., 2008), thus the benefits and limitations of these studies are inherent to the validity of the findings. While simulators offer control over external variables, such as road type and other road users, capturing realistic behaviour is compromised (Young et al., 2008). Yet, in naturalistic studies the focus of data collection is on the driver and their triggered engagement with secondary tasks as they allow very little control, and thus measurement of, the contextual factors that influence drivers' engagement with secondary tasks (Metz et al., 2015). The World Health Organisation (WHO) now acknowledges the sociotechnical system based approach which identifies driver behaviour, not as a product of the individual, but as a product of systemic elements such as the road layout, road design, vehicle design, and the context surrounding the driving task (WHO, 2004). Despite this, the application of systems based error management approaches have been largely ignored (Salmon et al., 2010). The causal error taxonomy suggested by Stanton and Salmon (2009) states five key elements within the sociotechnical system which influence the conditions that lead to error; the driver, the vehicle, road infrastructure, other road users and environmental conditions. Thus, it can be suggested that the cause of distraction related errors is not limited to the driver, instead it is influenced by a multitude of other systemic actors.

Reviewing distraction with the sociotechnical systems 'risk management framework' (RMF) developed by Rasmussen (1997) revealed the impact that hierarchical levels of the system have on the emergence of distraction. Actors were revealed from the international and national committees (Parnell et al., 2017) who set the laws that are enforced by local governments and regulators that then feed down the framework to the manufacturers of devices and the interaction they have with the end user (Young and Salmon, 2012; Parnell et al., 2017). Rather than focusing on the drivers' decision to engage as the initiation of error, the systems approach gives an insight into the conditions through which the driver was permitted to engage with distracting technologies and how this behaviour influences the emergence of safety within the system as a whole. Yet, appropriate methods are required to assess the sociotechnical system (Young et al., 2013; Salmon et al., 2017).

In a first attempt to assess and model driver distraction from a sociotechnical systems approach, Parnell et al. (2016) developed the PARRC (Priority, Adapt, Resource, Regulate, Conflict) model of distraction, the first model of the behaviour to account for the contribution of systemic factors. This encompasses five key mechanisms through which in-vehicle technology may lead to distraction across the sociotechnical system, including 'goal priority', 'adapt to demand', 'resource constraints', 'behavioural regulation' and 'goal conflict' (Parnell et al., 2016). The PARRC model was developed through grounded theory methodology which determined the key factors involved in the emergence of distraction as evolved from the literature. The interconnections made between these mechanisms were shown to influence how distraction related behaviour emerged from the system, as well as the relevance of other systemic actors on the mechanisms. Readers are directed to Parnell et al. (2016) for further information. Application of the PARRC model mechanisms to an Accimap analysis suggested how actors in the system may be preventing the emergence of distraction or conversely leaving the system open to distraction (Parnell et al., 2017). This highlighted the role of legislation, developed through international and national committees that is then enforced through national laws, that targets hand-held mobile phone use but is more ambiguous on the use of other technologies. The ambiguity in legislation was shown to have led to the advancement of technologies and their implementation within the vehicle, despite a lack of evidence to suggest them to be safer than hand-held mobile phones (Parnell et al., 2017). Yet, the mechanisms of the PARRC model were drawn from the literature using grounded theory and therefore require validation through their application to other data sources, methods and/or investigators through the process of triangulation (Hignett, 2005; Rafferty et al., 2010).

This paper seeks to gain data from drivers on their self reported reasons for engaging with technology while driving. Questionnaires and online surveys have strived to gather responses on drivers' frequency of engaging with distractions and their views on the risks in doing so (e.g. McEvoy et al., 2006; Young and Lenné, 2010; Walsh et al., 2008; Zhou et al., 2009; Zhou et al., 2012). Yet, they are often prescriptive, posing closed questions that may limit the data to the agenda of the researcher (O'Cathain and Thomas, 2004). Instead, the causal factors that drivers deem to influence their decision to engage with distractions, and how this may result in distraction related events, is of interest (Young et al., 2008; Young and Lenné, 2010; Lee, 2014). The first experiment within this paper sought to obtain the drivers self-reported reasons for engaging with technology while driving using a semi-structured interview method to engage drivers in open-ended discussions on why they may be more, or less, likely to engage with various types of technology while driving. The inductive thematic analysis that was applied during the data analysis aimed to develop factors that drivers themselves deem to influence their engagement with technological tasks. The second experiment aimed to assess how the causal factors derived from the drivers in the interview study related to the causal factors that were developed from the literature in the development of the PARRC model (Parnell et al., 2016). This model is used for its ability to assess the sociotechnical system surrounding the behaviour (Parnell et al., 2016, 2017). The findings seek to assist in the provision of countermeasures that target the source of the issue, rather than observing with hindsight the effects of distraction.

2. Experiment 1

2.1. Aim

This experiment aimed to understand the drivers self-reported reasons for engaging with technological devices while driving and the involvement of the sociotechnical in their decision-making process. Previous research has sought to capture the drivers' use of technologies using questionnaires and online surveys, yet this study aims to capture the drivers' subjective perspective in their own words. This will involve the use of semi-structured interviews to elicit discussions with drivers on their likelihood of engaging with different technological tasks across different road types.

2.2. Method

2.2.1. Participants

Drivers with experience of UK roads were specified as the road types included within the semi-structured interviews related to those comprising the UK roadway system (Walker et al., 2013). A total of 30 participants were recruited (15 females, 15 males), across three age categories (18–30, 31–49, 50–65), with five females and five males in each category. Participants were recruited under the requirement that they held a full UK driving license and had a minimum of 1-years experience driving on UK roads (mean years experience = 19.5, SD = 13.08). They were also required to be frequent drivers, driving on a regular weekly basis in order for them to be exposed to situations where they may be inclined to engage with technology (mean hours spent driving a week = 9 h 45min, SD = 6 h 20 min). Participation was voluntary.

2.2.2. Data collection

To obtain the drivers own views on why they engage with technological devices while driving, semi-structured interviews were conducted. Semi-structured interviews have been used effectively to investigate other aspects of driving behaviour (Simon and Corbett, 1996; Gardner and Abraham, 2007; Tonetto and Desmet, 2016), but they have not been applied to study how driver distraction is viewed by drivers. Their application within this research allowed for open-ended questions that enabled drivers to generate concepts they deemed important to