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Multiple driver distractions: A systemic transport problem

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ABSTRACT

Strategies to contend with driver distraction may no longer be sufficient for the emerging variety of contemporary driver distractions. A more systematic and systemic approach holds promise for improved road safety but is not currently being developed. This systematic review of multiple driver distractions aims to address this gap and presents two key findings. Systematic classification of distracting tasks with respect to driving is challenging, and engagement with Multiple-Additional-to-Driving (MAD) tasks is almost universally detrimental to driving performance. A model is presented to assist in systematically characterising multiple driver demands. Identified literature is placed into context using the model and shortfalls are identified.

1. Introduction

This paper systematically reviews the literature on multiple driver distractions. It is argued that, to date, our traffic frameworks are not sufficiently equipped to evaluate or moderate driver distractions, be they from single or multiple sources. The stakes are high. Nearly 1.3 million people die each year from road traffic crashes (WHO, 2011) and by 2030 road traffic injury will be the fifth most prevalent global cause of death (WHO, 2011). Of those who die in road traffic crashes, inattention has been cited as either the most dangerous error or the second most dangerous drivers can make (Craft and Preslopsky, 2009). Indeed, it is estimated that anywhere between 16% and 80% of traffic crashes are directly or indirectly attributable to driver distraction (Dingus et al., 2006; NHTSA, 2010, respectively). Given its role in accident causation it is no surprise that driver distraction has already been the topic of in-depth study. Several notable literature reviews and books provide distillations of the state of knowledge, for example, Basacik and Stevens (2008), Ferdinand and Menachemi (2014), GHSA (2011), Kircher (2007), Ranney (2008), Robertson (2011), Young et al. (2003) and Regan et al. (2013). These reviews provide a comprehensive summary of much of the research effort in this area, and the interested reader is referred to them for general background. The picture presented is clear. Studies show that 70% of single vehicle or rear end crashes involved inattention (e.g. Ranney, 2008), and 30% of sampled drivers reported having to take crash avoidance action due to a driving distraction (Robertson, 2011). Despite this, there is currently not a universal definition of driver distraction even with commonalities in how it is understood and described (Regan et al., 2011). These include the idea of attention being diverted from the primary driving task by a competing activity, the presence of an internal or external source, something that compels or induces attention, and an assumption in the literature that, when distracted, driving performance is negatively affected (Drews and Strayer, 2008). Hedlund's (2006) definition of driver distraction (among others) seems to capture these commonalities rather well:

> "Distraction involves a diversion of attention from driving, because the driver is temporarily focused on an object, person, task, or event not related to driving, which reduces the driver's awareness, decision-making, and/or performance, leading to an increased risk of corrective actions, near-crashes or crashes" (Hedlund, 2006, p. 2).

A prominent feature of the distraction literature is the primacy given to an individual device, i.e., the mobile phone. It is considered important, however, to recognise other potential sources of driver distraction. McEvoy et al. (2006) conducted a survey based study in which drivers reported a range of distracting activities such as: lack of concentration (71.8%), adjusting in-vehicle equipment (68.7%), viewing outside people, objects or events (57.8%), talking to passengers (39.8%), drinking (11.3%), eating (6.0%) or smoking (10.6%). In the survey, mobile phone use was reported as distracting by 9% of respondents, a relatively modest contributor to self-reported distractors given the emphasis placed on it in the wider literature. In other survey work (Lansdown, 2012), respondents were asked to

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rate the most distracting activities experienced while driving. The three most distracting were: writing text messages, reading text messages and using a hand-held mobile telephone. The percentage of respondents reporting undertaking these activities while driving was 41%, 62%, and 53% respectively. Ten percent of drivers have been reported as using a mobile phone at any given time (Ranney, 2008; Goodman et al., 1999) and secondary task distraction from a phone has been recorded in 33% of crashes and 27% of near misses (Klauer et al., 2006). There is a temptation to view driver distraction in simple non-systemic ways when, even in the case of single devices like the mobile phone, the scope for additional complexity is large. For example, an incoming text message attracts the driver's visual attention by the screen lighting up, more often than not accompanied by an audio cue, both of which compete for the already limited attentional resources. The driver might engage with the device and manually input a response, via the key pad, leaving one hand on the steering wheel and thus decreasing their physical control of the vehicle. Further cognitive demand is exerted in responding to the content of the message. All of these visual, manual and cognitive distractions may occur while the vehicle is in motion (Regan et al., 2011). Further, text messaging may be only one 'task' of many concurrently presented by a modern 'phone'. Although dominating the distraction literature, mobile phones are now just one of many vectors with the potential to distract drivers, whether it is something brought into the car (like a satellite navigation system) or fitted to it from the factory (in car 'infotainment' systems for example). Indeed, there is a lag between the current literature and the most recent forms of new vehicle technology. This is a concern because the technological trajectory of vehicle design is accelerating (e.g. Walker et al., 2001; Barnard et al., 2011; Regan et al., 2013; Gikkas, 2013) and the thinking on driver distraction has to keep pace. We are no longer dealing with discrete devices with a defined distraction pathway, but multiple devices and multiple means by which driving-focussed cognitive resources may be eroded. Driver distraction, therefore, becomes a systems problem.

Systems thinking itself has an extremely long legacy (e.g., Von Bertalanffy, 1950; Trist and Bamforth, 1951; Clegg, 2000; Walker et al., 2008, 2010), but it is only comparatively recently that the concepts are beginning to find more widespread use in the road safety domain (e.g., Young et al., 2013; Salmon et al., 2012). Systems thinking requires a shift in our focus. Instead of component parts like mobile phones, and linear chains of cause and effect (e.g., Heinrich, 1941) that link them to defined distraction outcomes; there should instead be a focus on more complex and sophisticated forms of new technology. How do the human and technological components interact, and will unexpected properties emerge (Walker et al., 2009)? A lack of 'systems thinking' could exacerbate the risks to drivers as new technology creates new possibilities for, as yet, un-thought of interaction possibilities. Potential problems may become difficult to detect using existing experimental methods, as these do not always scale well with additional complexity (Walker et al., 2010). The systems view is highly compatible, indeed synonymous, with the emerging picture of multiple distractions. Once isolated systems are becoming integrated into ever more complex in-vehicle networks. All of this occurs before consideration of the multitude of social, organisational and technical component interactions; a theme developing rapidly in the road safety literature (e.g., Salmon et al., 2012). Indeed, to take a lead from Dekker's (2011) sometimes controversial work on systems thinking, and extend this metaphor to its limit, even the term 'driver distraction' may no longer be appropriate. Is it only the driver who is distracted? Or is it the system that permits them to become distracted and allows knock-on effects to propagate further? This is a moot point. Less arguable is the evidence for distraction, its contribution as a major factor in road traffic crashes, and the social and economic cost in human distress. What remains important is to understand, classify and test the structure, scope and impact of driver distraction from a 'systems' perspective. To do this a first systematic review of driver's engagement with Multiple Additional-to-Driving (MAD) tasks is undertaken. It seeks to address three main questions, (i) how many publications have explicitly considered the problem, (ii) what is the impact on driving, and (iii) what are the interconnections between sources of distraction, drivers and their wider context? For the purposes of this review the driving system is considered to be any and all components contributing to safe travel from one point to another. Sub-systems in this regard may contribute constructively to the larger system goal, or not. These may include, for example, the driver's capabilities, the road and vehicle conditions, other road users, and/or any non-driving activities undertaken. Each sub-system interacts with the others as part of the larger system from the perspective of the driver. This system, in-turn, is considered to interact as a sub-system to the road network at large, and so on. Evidence of the scope for multiple distractions and a model to characterise them are presented.

2. Method

The search and review strategy is described below. A comprehensive review of the English-language scientific literature was performed. It encompassed the period from 1st January, 1975 to 31st August, 2013. The following databases were interrogated: EBSCO, ScienceDirect, Google Scholar and Web of Knowledge. Search terms employed were: multiple OR concurrent, AND distraction, demand, in/attention, visual, cognitive, manual, driver performance, phone, cellular, conversation, talk, sms, email and instant message AND car, vehicle, truck OR driv*. 2273 items were returned from the search criteria above. These were then reviewed using the following criteria.

2.1. Exclusion criteria

Exclusion criteria were papers that were obviously non-relevant or from medical, electronic, networking, marketing and patent topics. These included case reports, letters to the editor, book reviews, and/or policy papers. Additionally, both non-automotive studies and substance use studies (e.g., alcohol or marijuana) were not considered unless they embodied a clear systems perspective (e.g., in terms of multiple distractors, use of systems thinking, a focus on interactions and/or emergent properties).

2.2. Inclusion criteria

Only publications from peer-reviewed English-language journals were considered for inclusion. Peer review of candidate empirical publications was adopted as the primary criteria for methodological quality review. Potential investigations may have included randomised trials, pre-post studies, cohort studies, descriptive investigations, and/or case control studies.

Seventy resultant publications were reviewed with respect to (i) design, (ii) independent variable/s, (iii) dependent variable/s, and (iv) findings. Studies were included in the review if they addressed MAD distractions. MAD tasks were operationalised as more than one concurrently attempted Single Additional-to-Driving (SAD) task, as defined above. Further, MAD tasks were required to take place during broadly the same time period. The implications of this criterion are discussed in more detail below.

References and bibliographies from the seventy papers identified were examined in more detail to determine potential additional papers and make a second more rigorous selection. Keywords reported above were applied to the ISI Web of Knowledge to identify impactful researchers. Five of these researchers were contacted via email and telephone between the 3rd and 5th June

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