‘Do Not Disturb While Driving’: Distractibility of Tesla In-Vehicle Infotainment System

Rachael A. Wynne & Stephanie Dolman

School of Psychological Sciences, The University of Newcastle, Callaghan, Australia

---

SUMMARY

Driver distraction is recognised as a leading cause of road deaths and fatalities. Driving is a complex task and with the increasing availability of consumer technology including in-vehicle infotainment systems (IVISs) the potential for distraction and resultant collisions is increasing. Operator event sequence diagrams (OESDs) were created to model use of the Tesla system, allowing operator load scores to be derived as a measure of driver distractibility for the Tesla IVIS across a series of tasks. It was consistently observed that the lowest operator loads involved voice recognition systems, hence greater availability of these systems may help to decrease distraction and thereby improve road safety. Future research will expand to focus on more systems to better understand the interaction between IVISs and drivers and the impact on driver distractibility.

KEYWORDS

Distracted driving, in-vehicle distraction, modelling, OESDs

Introduction

Driving is a common activity undertaken by millions of adults daily; estimates suggest there were approximately 19.2 million active driver licences in Australia in 2016 (Bureau of Infrastructure, Transport and Research Economics, 2017), and 19.8 million registered vehicles as of 31 January 2020 (Australian Bureau of Statistics, 2020). Despite being a common activity, driving poses a significant safety risk. Globally, motor vehicle crashes are a leading cause of death and injury with estimates of 1.3 million fatalities and 20-50 million non-fatal injuries yearly (WHO, 2022).

In Australia, though the number of road fatalities has generally decreased over time (Bates et al., 2021), 2022 saw an increase to the highest level in 5 years (McLellan, 2023). Additionally, serious injuries have been increasing (Bates et al., 2021) with approximately 40,000 people injured in road crashes each year. In response to road fatalities and injuries the Australian Government has set targets to decrease fatalities by 50% and serious injuries by 30% by 2030 through the National Road Safety Strategy (Commonwealth Government of Australia, 2021). If the recent increase in road fatalities of 2022 continues, these targets are unlikely to be met.

While many factors in the vehicle and environment contribute to road safety, a critical and variable component is the driver (Ojstersek & Topolsek, 2019). Drivers must simultaneously deal with a range of activities including considering speed limits, signs and other road users while contending with general thoughts (Knapper et al., 2015). With all these activities and potential distractions, the driver must maintain their eyes on the road and mind focused on driving (Cooper et al., 2020). As a distracted driver can represent a threat to road safety, (Bates et al., 2021; Beanland et al., 2013; Jazayeri et al., 2021) this study aims to investigate driver distraction.

Driver Distraction

Driver distraction, now commonly defined as "diversion of attention away from activities crucial for safe driving toward a competing activity, resulting in insufficient or no attention to activities critical for safe driving" (Reagan et al., 2011, p1776) is a leading cause of injuries and fatalities (Ebel et al., 2023). Distracted drivers are two times more likely to be involved in car crashes (Dingus et al., 2016) with data from the United States suggesting 10% of fatal incidents and 18% of incidents causing injuries are due to distracted driving (Blincoe et al., 2015). In Australia, driver distraction has been estimated to cause 16% of crashes (Beanland et al., 2013). Driver distraction does not always result in a crash but when it does the most common sources of distraction have been found to be interactions with passengers, use of mobile phones and use of in-vehicle infotainment systems (IVISs) (Liang & Yang, 2022). Though there are many types and reasons for driver distractions, due to their ubiquity research has predominantly centred on mobile phone use (Baites, 2021; Ziakopoulos et al., 2019).

Mobile Phones

Research on mobile phones has focussed on the impacts of having a conversation and of using a mobile phone to dial a number on both driver behaviour and crash risk. Atchely and Dressel (2004) and Strayer and Johnston (2001) established that when drivers talk on a phone there is a negative effect on cognitive and attentional capacity. Analysis of crashes has suggested an increase in crash risk when drivers were talking on mobile phones immediately prior to an incident (McEvoy et al., 2005). While talking on the phone increases the risk of a crash, dialling a number has also been found to increase driver reaction time and increases the number of off-road glances (Caird et al., 2018), thereby increasing the risk of a distracted driver. Driver distraction due to using mobile phones in vehicles is well established and has garnered a lot of attention from the public and policy makers (Strayer et al., 2021).

In response, many countries have banned the use of mobile phones in vehicles (Caird et al., 2018). While legislation has been enacted to address the use of mobile phones while driving such laws do not always extend to other forms of distraction which may operate via similar mechanisms, representing an inconsistency. Atchley and Strayer (2017) observed that touchscreens used to operate an IVIS are like phones and should be considered similarly. Additionally, even though one may use a mobile phone in a cradle, research has indicated that a touchscreen interface on either a phone or an IVIS can create high levels of visual demand due to a lack of tangible feedback (Young & Lenne, 2010). Atchely and Strayer (2017) question why holding and/or touching a phone in a specific way is banned, while operating an IVIS using a touchscreen is allowed.

IVISs

IVISs are electronic devices built into cars, providing diverse functions to the driver including entertainment (e.g., music), information (e.g., directions, weather) and communication (e.g., phone calls). Such functions are secondary tasks to driving, hence IVISs may be creating opportunities for distracting secondary tasks to be performed (Alarcón et al., 2022). IVIS functionality has increased in breadth and complexity over time (Strayer et al., 2019b), and their availability is generally increasing, with most new vehicles now offering an IVIS as standard (Ebel et al., 2023), often involving a large touchscreen such as those seen in the Tesla3 (Ebel et al., 2023). With this increase in availability and functionality, it is increasingly important to understand how IVISs may impact distraction and safety (Platten et al., 2013).

A meta-analysis by Ziakopoulos et al. (2019) found 1.66% of crashes were caused by the driver's use of IVISs and that the odds of crashes due to operating IVIS were very low. While this appears to be positive, the authors acknowledged that due to this being an area of limited research with only a small number of studies available, the results must be interpreted with caution. Since IVIS design and functionality has changed over the intervening years, contemporary research is required to evaluate the impact of IVISs that are now available. Furthermore, little is known about how drivers interact with these systems (Cooper et al., 2020), or the impact of the diverse functionality of IVISs on driver workload (Strayer et al., 2019), both of which could be a target of further research.

Workload from operating an IVIS may vary due to differences in task duration, mode of interaction and the specific secondary task being performed, with higher complexity and longer tasks leading to higher workloads (Strayer et al., 2019a). While specific IVISs might become familiar to vehicle owners over time, practice with IVISs has not been found to mediate the impact on workload.

The nature of the secondary task undertaken via IVIS may impact workload. Audio entertainment tasks have been found to be least demanding, followed by text messaging, with navigation having the highest workload (Strayer et al., 2019b). As workload may differ by task nature and duration, the specific functions offered by IVISs are important to consider. Additionally, the mode of interaction of the driver with the IVIS may also affect workload.

There are conflicting findings regarding the relative workloads of different modes of interaction. In mobile phones, voice recognition was introduced to help drivers avoid visual-manual interfaces (touchscreen, buttons and dials) lowering demand for visual resources (Reagan & Kidd, 2013) which were found to be distracting (Coppola & Morisio, 2017; Simmons et al., 2017). However, early research into IVISs suggested high cognitive demands from voice recognition (Strayer et al., 2015) which drivers self-reported as being higher than operating the centre stack (Mehler et al., 2016). A more recent study contradicts this, suggesting lower cognitive demands from voice recognition relative to other interaction modes (Strayer et al., 2019a). Adding to the complexity, while voice recognition aims to decrease visual and manual input, it may lead to visual inattention if drivers seek to confirm the success of their voice commands (Caird et al., 2015).

Factors that impact inattention caused by voice controlled IVISs include task duration, delay time, menu depth, menu complexity and accuracy of the voice recognition system (Chang et al., 2009; Biondi et al., 2019). High accuracy systems have been found to produce a lower workload than systems with medium accuracy (Strayer et al., 2014). Menu structure was found to play a particularly important role on workload, with more complexity producing greater processing time. Hence to improve safety it is not sufficient to simply have a voice recognition system available, the system must accurately respond to voice commands, using menu structures which minimise depth and complexity.

IVIS functionality has increased in breadth and complexity over time (Strayer et al., 2019), and availability is increasing, with most new vehicles now offering an IVIS as standard often involving a large touchscreen such as those seen in the Tesla 3 (Ebel et al., 2023). Tesla models continue to dominate the Australian electric vehicle market, (Federal Chamber of Automotive Industries, 2023) and given their unique design, the level of distractibility of this system is of interest to researchers. This paper presents an evaluation of the IVIS of a Tesla Model 3 to determine the workload associated with completing typical tasks.

To evaluate this, a human factors approach was adopted, specifically, Operator Event Sequence Diagrams (OESDs) were used. OESDs are a pictorial representation that allow us to model the interaction between people and technology in a graphical manner across different tasks (Stanton et al., 2013). They can range from simple to complex and are an effective technique to illustrate who is doing what, when. While typically used during the design phase, OESDs can also be used to compare existing systems (Harris et al., 2015). The advantages of OESDs are that they provide a complete and full analysis of tasks and demonstrate high validity (Stanton et al., 2021). Also, the technique can be applied across different industries and domains due to its flexibility, demonstrated by its use in both commercial aviation (Harris et al., 2015) and driving (Stanton et al., 2022).

Method

Operator event sequence diagrams (OESDs) are a pictorial representation that allow us to model the interaction between people and technology in a graphical manner across different tasks (Stanton et al., 2013). They can range from simple to complex and are an effective technique to illustrate who is doing what, when (Harris et al., 2015; Stanton et al., 2021a). While typically used during the design phase, OESDs can also be used to compare existing systems (Harris et al., 2015). The advantages of OESDs are that they provide a complete and full analysis of tasks and demonstrate high validity (Stanton et al., 2021a). Additionally, the technique can be applied across different industries and domains due to its flexibility, demonstrated by its use in both commercial aviation (Harris et al., 2015) and driving (Stanton et al., 2021b; Stanton et al., 2022).

Creating an OESD first requires defining the tasks under analysis. Data for those tasks are then collected, then mapped out by a hierarchical task analysis (HTA) (Stanton et al., 2013). An HTA maps out the steps taken for a specific task, allowing construction of an OESD for each task. To complete the process, operator load scores are calculated by counting the steps required for each task (Banks et al., 2024). By calculating operator loads and comparing scores, the performance of different systems for the same tasks may be compared (Banks et al., 2024).

In an OESD each actor in the system (for example one actor is the driver and the other the machine) is represented separately through columns, colloquially known as ‘swim lanes’ (Parnell et al., 2023; Stanton et al., 2021b). This ensures consistent representation of performance across systems and between actors enabling side-by-side comparison of tasks (Banks et al., 2024). Time is represented on the left-hand side of the swim lanes and is a general reflection of time passing as one advances in the process, it does not represent an accurate measurement of time.

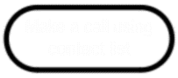
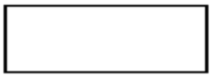
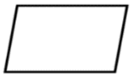
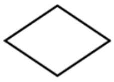
The selection of methodology in Human Factors research often comes down to practical considerations such as time, available expertise and cost (Parnell et al., 2023a). OESDs have previously been used in the driving context and their use requires minimal training (Stanton, 2013). Disadvantages include that OESDs can be time consuming to construct, can be large and confusing, and due to different analysis of symbols their reliability can be questionable (Stanton, 2013). There have been suggestions that as OESDs are “work as imagined” rather than “work as done” (Hollnagel 2015; Read et al., 2018), raising concerns as to whether users would use the machines as predicted (Stanton et al., 2021a). Research by Stanton et al. (2021a) found that the use of OESDs predicted the behaviour of drivers 87.5% of the time, so we can conclude that OESDs are a useful method to predict human-machine interactions (Stanton et al., 2013; Stanton et al., 2021a). Comparisons of operator loads from the OESDs were used to draw conclusions regarding which systems create higher levels of driver distraction, under the assumption that the higher the operator load, the higher the level of distraction.

Testing of IVIS

The five popular tasks were tested and modelling the operator load using OESDs (play a song, make a phone call, input an address, tune the radio, receive a phone call). The authors recorded themselves performing the tasks within a 2022 Tesla 3 model used videos to develop HTAs which were then used to build the individual OESDs for each task, separated by modes of interaction. Once the OESDs were completed, driver operator load scores were calculated for each task, vehicle and mode of interaction.

An OESD key can be seen in Table 1, this combines the key system of Stanton et al. (2021b) and Banks et al. (2024). Following the standard procedure for creating OESDs (Stanton et al., 2021a) an author produced the OESDs which were reviewed by a Human Factors researcher with seven years' experience in the application of Human Factors methods including OESDs. Any disagreements regarding HTA's and OESDs were resolved via discussion.

Table 1: OESD Key

Symbol	Name	Meaning
	Start/End	Start/End of process
	Process	A generic task or process
	Data	Data or information is received including vocal information
	Decision	A decision where two or more possibilities
	Communication	Audio output
	Display	Display output
	Manual input	Engaged in a manual task

Note. Adapted from Stanton et al. (2021b) and Banks et al. (2024)

Results

For the five tasks, HTAs were created for all available modes of integration (voice recognition and touch screen). The number of operations per task appear in Table 2. OESDs and driver operator loads were calculated for each OESD and compared between across the interaction modes. Voice recognition tended to have lower operator loads, showing the relatively good performance of the voice recognition systems when compared by operator load to other modes of interaction.

Table 2: Summary of Hierarchical Task Analysis for Tasks by Manufacturer

Task	Number of Operations by Mode of Interaction	
	Voice Recognition	Touchscreen
Play a song	3	4
Receive a call	N/A	1
Input address	3	4
Tune radio	2	4
Make a call	4	6
(Dialling)	2	4

Discussion

The aim of this exploratory research was to investigate the operator load of completing a series of IVIS tasks in a Tesla 3 across a variety of input modes. Distractibility, measured through operator load, was found to vary across most tasks, systems, and modes of interaction. Those systems with lower operator loads could be less distracting, than those with a higher operator load.

The more steps that were involved in producing the task, may lead to higher distraction (Strayer et al., 2019). Therefore, design improvements, to reduce the number of steps required in a touch screen, may reduce distraction. While the Tesla did not involve many steps, which may be seen to reduce distraction, there appears to be at the cost of a verification step. Other systems allow the driver to check the number before dialling, the Tesla did not. Banks et al. (2024) in research on pilots found that a lack of verification can increase the rate of errors. While verification steps can increase operator load for a task, if this does not occur then a task performed in error will need to be corrected or repeated (Reagan & Kidd, 2013), increasing operator load and driver distraction. Care should be taken to weigh the improvements in operator load that arise from removing a check, if that removal leads to a substantial rate of error. Further research could be undertaken to explore this balance within IVIS settings and to identify situations where the rate of error is sufficiently high to justify the cost in operator load imposed by a check.

For inputting an address, the Tesla had a fairly low operator load score (see Table 2). Previous research by Strayer et al. (2019a) found navigational tasks had a higher workload than text messaging and audio tasks. The finding that the Tesla had a much lower operator load for a navigational task indicates there are design choices allowing improvements in operator load even for tasks that are generally deemed to be more complex. If, as was found, Tesla can create an operator load half that of the highest option observed in other systems, those systems have significant room for improvement which could result in lower levels of distraction.

The cases of higher operator load were due to a deeper menu structure, with the driver required to press more buttons to complete the task. This means more time would be spent by the driver focussed on the secondary task which could result in more frequent glances off the road and higher levels of distraction, leading to a higher risk of an adverse event (Biondi et al., 2019). By reducing menu depth, drivers can spend less time on secondary tasks, reducing distraction and resultant collisions. Potential distraction could be reduced by making more reliable modes of verbal interaction available. Several studies have reported that ease of use, reliability and usefulness influence whether drivers use voice recognition systems over visual-manual systems such as touchscreen and buttons (Ibrahim, 2019). Additionally, traffic density and the driving environment could impact use of voice recognition systems with drivers more likely to use these systems on freeways than in the CBD (Ibrahim, 2019). Having more options available could reduce the risk of distraction by allowing the driver to select the most appropriate option for their situation.

While the Tesla voice recognition system was assessed as having the lowest or tied lowest operator load for four tasks, it would often start off as a voice recognition system but return to the touchscreen to finish a task. This introduces mixed perceptual modalities into a secondary task, increasing the potential for resource competition with the primary task of driving in line with the MRT model (Wickens, 2008). Additionally, while all voice recognition system can sometimes be prone to errors, the Tesla's voice recognition system was found to be noticeably more challenging in this regard. The author had to attempt to change vocal inflections and accent to be understood by the system, raising concerns of accuracy and usability. Previous research by Strayer et al. (2014) found that accuracy in voice recognition impacts workload: the less accurate the system, the higher the workload. When entering an address, words unique to Australia resulted in system error responses and numerous failed attempts, before the author reverted to using the touchscreen to enter the address. Not only does this reversion add additional time and steps for successful task completion, it also adds modalities to the task which may increase the potential for attentional resource competition as described by MRT (Wickens, 2008). These difficulties are not apparent in the scores shown due to the assumption made that tasks were successfully completed, for the purposes of completing the OESDs and operator load scores, but the risk and impact of errors should be considered when designing IVISs. Importantly, a voice recognition system needs not only to be available, but it must also be useable and accurate (Harvey et al., 2011; Strayer et al., 2014).

Voice recognition systems were not available in all systems for all tasks, which may represent an area of opportunity to improve driver distraction in those vehicles and for those tasks.

Conclusion

This research is the first of a larger research project to explore how Australian drivers use modern IVISs and their potential impact on distractibility. We found that a wide range of distractibility for those tasks across and modes of interaction as measured by operator load. Generally, tasks completed with voice recognition options were found to have the lowest operator load, though the voice recognition systems tested also exhibited challenges of accuracy and usability which may limit their utility for improving distractibility, unless this can be improved. Driver distraction is an important area of research due to its established impact on road safety and road injuries and fatalities. To address the present study's limitations of a restricted selection of IVISs, only one individual creating the OESDs, voice recognition not being accurate and stationary testing, further research is needed to explore how Australian drivers use IVISs, especially in a live environment.

References

Alarcón, J., Balcázar, I., Collazos, C. A., Luna, H., & Moreira, F. (2022). User interface design patterns for infotainment systems based on driver distraction: A Colombian case study. *Sustainability, 14*(13), 8186.

Atchley, P., & Strayer, D. L. (2017). Small screen use and driving safety. *Paediatrics, 140*, S107-S111.

Australian Bureau of Statistics (2020. June). Survey of Motor Vehicle Use, Australia. https://www.abs.gov.au/statistics/industry/tourism-and-transport/survey-motor-vehicle-use-australia/latest-release#articles

Banks, V. A., Griffin, T. C., Parnell, K. J., Plant, K. L., Wynne, R. A., & Stanton, N. A. (2024). Increasing connectivity: Using Operator Event Sequence Diagrams to show the impact of new technology on the flight deck. *Human Factors and Ergonomics in Manufacturing & Service Industries. 34*(1) 53-62.

Bates, L., Alexander, M., Van Felius, M., Seccombe, J., & Bures, E. (2021). *What is known about distracted driving?* https://www.aaa.asn.au/wp-content/uploads/2021/04/DD2020-01-AAA-Distracted-Driving-Review-FINAL.pdf

Beanland, V., Fitzharris, M., Young, K.L., & Lenne, M.G. (2013). Driver inattention and driver distraction in serious casualty crashes: Data from the Australian National Crash In-depth Study. *Accid Anal Prev, 54*, 99-107.

Biondi, F. N., Getty, D., Cooper, J. M., & Strayer, D. L. (2019). Examining the effect of infotainment auditory-vocal systems' design components on workload and usability. *Transp Res Part F Traffic Psychol Behav, 62*, 520-528.

Blincoe, L., Miller, T. R., Zaloshnja, E., & Lawrence, B. A. (2015). *The economic and societal impact of motor vehicle crashes, 2010 (Revised)*. (No. DOT HS 812 013).

Bureau of Infrastructure, Transport and Research Economics (2017, February). Drivers Licences in Australia. Australian Government Department of Infrastructure, Transport, Regional Development, Communication and the Arts.

Caird, J. K., Simmons, S. M., Wiley, K., Johnston, K. A., & Horrey, W. J. (2018). Does talking on a cell phone, with a passenger, or dialling affect driving performance? An updated systematic review and meta-analysis of experimental studies. *Human Factors, 60*(1), 101-133.

Chang, J., Lien, A., Lathrop, B., & Hees, H. (2009). Usability evaluation of a Volkswagen Group in-vehicle speech system. *Proceedings of the 1st International Conference on Automotive User Interfaces and Interactive Vehicular Applications*, 137–144.

Commonwealth Government of Australia (2021) *National Road Safety Strategy 2021-30*. Department of Infrastructure, Transport, Regional Development and Communications

Cooper, J. M., Wheatley, C. L., McCarty, M. M., Motzkus, C. J., Lopes, C. L., Erickson, G. G., Baucom, B.R.W., Horrey, W.J., & Strayer, D. L. (2020). Age-related differences in the cognitive, visual, and temporal demands of in-vehicle information systems. *Frontiers in Psychology, 11*, 1154.

Coppola, R., & Morisio, M. (2017). Connected car: Technologies, issues, future trends. *ACM Computing Surveys, 49*(3), 1–36.

Dingus, T.A., Guo, F., Lee, S., Antin, J.F., Perez, M., Buchanan-King, M., & Hankey, J. (2016) Driver crash risk factors and prevalence evaluation using naturalistic driving data. *Proceedings of the National Academy of Science, 113*(10), 2636-2641.

Ebel, P., Lingenfelder, C., & Vogelsang, A. (2023). On the forces of driver distraction: Explainable predictions for the visual demand of in-vehicle touchscreen interactions *Accid, Analy & Prev, 183*, 106956–106956.

Federal Chamber of Automotive Industries (2023, 3 February). FCAI releases January 2023 car sales data. https://www.fcai.com.au/news/index/view/news/789

Harris, D., Stanton, N. A., & Starr, A. (2015). Spot the difference: Operational event sequence diagrams as a formal method for work allocation in the development of single-pilot operations for commercial aircraft. *Ergonomics, 58*(11), 1773–1791.

Hollnagel, E. (2015) Why is work-as-imagined different from work- as-done? In R.L. Wears, E. Hollnagel., & J. Braithwaite (Eds), *Resilient Health Care Volume 2* (1st ed., pp. 249-264). Aldershot, Ashgate.

Ibrahim, N.I. (2019). Safety impacts of using smartphone voice control interfaces on driving performance. [Unpublished Doctoral Dissertation] https://doi.org/10.26190/unsworks/21177

Jazayer, A., Martinez, J.R.B., Loeb, H.S., & Yang, C.C. (2021). The impact of driver distraction and secondary tasks with and without other co-occurring driving behaviors on the level of road traffic crashes. *Accid Anal Prev, 153*, 106010.

Knapper, A. S., Hagenzieker, M. P., & Brookhuis, K. A. (2015). Do in-car devices affect experienced users' driving performance? *IATSS Research, 39*(1), 72-78.

Liang, O. S., & Yang, C. C. (2022). How are different sources of distraction associated with at-fault crashes among drivers of different age gender groups? *Accid Anal & Prev, 165*, 106505.

McEvoy, S. P., Stevenson, M. R., McCartt, A. T., Woodward, M., Haworth, C., Palamara, P., & Cercarelli, R. (2005). Role of mobile phones in motor vehicle crashes resulting in hospital attendance: a case-crossover study. *BMJ, 331*(7514), 428–430.

McLellan, T. (2023). More than 1,160 people died on Australian roads in 2022. Why is our death toll worsening? Australian Broadcasting Corporation.

Mehler, B., Kidd, D., Reimer, B., Reagan, I., Dobres, J., & McCartt, A. (2016). Multi-modal assessment of on-road demand of voice and manual phone calling and voice navigation entry across two embedded vehicle systems. *Ergonomics, 59*(3), 344-367.

Parnell, K. J., Stanton, N. A., Banks, V. A., & Plant, K. L. (2023b. Resilience engineering on the road: Using operator event sequence diagrams and system failure analysis to enhance cyclist and vehicle interactions. *Applied Ergonomics, 106*, 103870–103870.

Platten, F., Milicic, N., Schwalm, M., & Krems, J. (2013). Using an infotainment system while driving – A continuous analysis of behavior adaptations. *Transp Res Part F Traffic Psychol Behav, 21*, 103–112.

Reagan, I. J., & Kidd, D. G. (2013). Using hierarchical task analysis to compare four vehicle manufacturers' infotainment systems. *Human Factors and Ergonomics, 57*, 1495-1499.

Reagan, M. A., Hallet, C., & Gordon, C.P. (2011). Driver distraction and driver inattention: Definition, relationship and taxonomy. *Accid, Analy & Prev, 43*, 1771-1781.

Simmons, S. M., Caird, J. K., & Steel, P. (2017). A meta-analysis of in-vehicle and nomadic voice-recognition system interaction and driving performance. *Accid, Analy & Prev, 106*, 31-43.

Stanton, N. A., Brown, J. W., Revell, K. M. A., Clark, J., Richardson, J., Langdon, P., Bradley, M., Caber, N., Skrypchuk, L. & Thompson, S. (2021) Modelling automation–human driver handovers using Operator Event Sequence Diagrams. *Future Transportation, 1*, 351–369.

Stanton, N. A., Brown, J. W., Revell, K. M. A., Richardson, J., Langdon, P., Bradley, M., Caber, N., Skrypchuk, L., & Thompson, S. (2022). OESDs in an on-road study of semi-automated vehicle to human driver handovers. *Cognition Technology Work, 24,* 317–332.

Stanton, N. A., Salomon, P. M., Rafferty, L. A., Walker, G. H., Baber, C. & Jenkins, D. (2013). *Human factors methods: A practical guide for engineering and design* (2nd ed.). Ashgate

Stanton, N.A., Brown, J., Revell, K.M.A., Langdon, P., Bradley, M., Politis, I., Skrypchuk, L., Thompson, S., & Mouzakitis, A. (2021). Validating Operator Event Sequence Diagrams: The case of an automated vehicle to human driver handovers. *Human Factors and Ergonomics in Manufacturing & Service Industries, 32*(1), 89-101.

Strayer, D. L., & Johnston, W. A. (2001). Driven to distraction: Dual-task studies of simulated driving and conversing on a cellular telephone. *Psychological Science, 12*(6), 462-466.

Strayer, D. L., Cooper, J. M., Goethe, R. M., McCarty, M. M., Getty, D. J., & Biondi, F. (2019). Assessing the visual and cognitive demands of in-vehicle information systems. *Cognitive Research: Principles Implications, 4*(1), 18.

Strayer, D. L., Drews, F.A., & Johnston, J. M. (2003). Cell phone-induced failures of visual attention during simulated driving studies. *Journal of Experimental Psychology: Applied. 9*(1). 23–32.

Strayer, D. L., Getty, D., Biondi, F., & Cooper, J. M. (2021). The multitasking motorist and the attention economy. *Human Capacity in the Attention Economy*. 135-156.

Strayer, D. L., Turrill, J., Coleman, J. R., Ortiz, E. V., & Cooper, J.M. (2014). Measuring cognitive distraction in the automobile ii: Assessing in-vehicle voice-based. *Accid, Analy & Prev*, *372*, 379.

Wickens C. D. (2008). Multiple resources and mental workload. *Human Factors, 50*(3), 449–455.

WHO (2022). Key Facts on Road Traffic Injuries. www.who.int/news-room/fact-sheets/detail/road-traffic-injuries

Young, K. L., & Lenne, M. G. (2010). *Risks associated with in-vehicle technology use while driving*. Monash University Accident Research Centre, Victoria, Australia.

Ziakopoulos, A., Theofilatos, A., Papadimitriou, E., & Yannis, G. (2019). A meta-analysis of the impacts of operating in-vehicle information systems on road safety. *IATSS Research, 43*(3), 185-194.