# What technologies do people engage with while driving and why?

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# Abstract

This paper presents the findings of a semi-structured interview study that was conducted to identify drivers’ self-reported likelihood of engaging with technologies that are now commonly found in modern automobiles. Previous research has focused on the effect these technological tasks have on driving performance, but there has been less focus on how, why and when drivers choose to engage with them. As distraction remains a significant contributor to road accidents, an understanding of why it occurs will give important insights into how it can be prevented. A semi-structured interview schedule was developed to allow drivers to discuss the factors that influence their decision to engage with a variety of different technologies. The methodology facilitated both quantitative ratings of the drivers’ likelihood of engaging in a variety of tasks and qualitative insights into why. Age and gender had some influence on the propensity to engage, in line with other findings in the literature, as did road type and task type. The reasons drivers gave for why they engage with potentially distracting tasks inform recommendations for preventing distraction related accidents from the increasingly prevalent sources of technologies available to drivers.

**Key words: In-vehicle technology, Driver distraction, Qualitative methods; Willingness to engage.**

# 1. Introduction

The popularity of mobiles phones has notoriously had a negative effect on road safety (see McCartt et al, 2006 for a review). The coupling of a high willingness to engage (Young & Lenné, 2010) and the adverse effects they have on the drivers’ visual monitoring of the road (Reimer, 2009), vehicle control (Törnros & Bolling, 2005), and speed (Alm & Neissen, 1995) have encouraged the decision to ban drivers from using hand-held telephone devices across many countries globally. Yet, technological advancements have facilitated a host of other devices for drivers to interact with. This includes those that aid the driving task, e.g. sat-navs and eco-displays, in addition to those that provide alternative functionalities e.g. music players and hands-free telephones, that are proposed as ‘safer’ alternatives to hand-held devices although this is not always the case (Strayer & Johnston, 2001; Horrey & Wickens, 2006). A movement towards wearable technologies is also likely to impact road safety (e.g. Sawyer et al, 2014), as technology develops faster than legislation is able to control appropriate use (Leveson, 2011). Compared to research into mobile phone use, research into other technological devices is scarce, although the distractive potential and their relationship to accidents is becoming evident (e.g. Tsimhoni et al, 2004; Rouzikhah et al, 2013; Lee et al, 2012). This has led to the current laws that focus specifically on hand-held phones to be questioned (Parnell et al, 2017a).

Age is reported to be a significant factor contributing to the drivers’ engagement with technological devices (e.g. Lamble et al, 2002; Lerner, 2005; McEvoy et al, 2006; Chen et al, 2016; Pope et al, 2017). This is thought to relate to the relationship between age and access to technology, for example younger drivers have been found to have a higher ownership of mobile phones that has been linked to their increased use while driving in this demographic (Lamble et al, 2002). Although, this effect seems to have decreased in recent years with older adults becoming more accepting of technologies (Mitzner et al, 2010). Yet, older drivers have been found to show more disapproving attitudes towards mobile phone use when driving (Mizenko et al, 2015) and are more in favour of increased restrictions on their use (Lamble, 2002). There is also evidence to suggest that older drivers more adversely effected by the increased demand of managing secondary tasks while driving (Alm & Nilsson, 1995; Reed & Green, 1999). Furthermore, Strayer and Drews (2004) found that, while the impact of performing a phone based secondary tasks on driving performance was equivalent in younger and older drivers, the younger drivers’ performance when on the phone was the same as the older drivers when they were not engaging with the phone secondary task. Yet, younger drivers are also more likely to underestimate the effect that mobile phones have on their driving behaviour (Tison et al, 2011) and are also more likely to self-report engaging in the use of devices while driving (McEvoy et al, 2006). Although, caution should be heeded when discussing and selecting age categories as recent findings suggest that a middle age category (those between young and old adults) may be similar to the younger drivers in their acceptance and inclination to use technology while driving (Engelberg et al, 2015; Pope et al, 2017). As a generation of drivers who are accustomed to the use of technologies grow older, the interaction between their cognitive ageing, which is also linked to reduced driving performance e.g. Strayer and Drews (2004), and their potential to engage with distractions needs to be considered for future road safety (Pope et al, 2017). The effect of gender and age have also been evidenced with the suggestion that older females are the least likely demographic to engage with mobile phones and younger males the most likely (Pöysti et al, 2005; Lamble et al, 2002).

The impact of distracting tasks has also been linked to environmental conditions and circumstances such the complexity of the roadway environment (Horberry et al, 2006), manoeuvring different road segments (Lerner et al, 2005), and the curvature of the roadway (Kountouriotis & Merat, 2016). These factors have been found to effect the compensatory mechanisms that drivers employ when engaging with secondary tasks, e.g. slowing down (Rakauskas et al, 2004; Cnossen et al, 2004), an effect that has been found to be exaggerated with age (Horberry et al, 2006). Road type has also been linked to the structure and content of drivers’ situational awareness, with different road environments altering driver perceptions and behaviour (Walker et al, 2013). Engagement with distractions is deemed by some to be largely voluntary, with as estimated 70% of distractions being actively engaged by the driver (Beanland et al, 2013). There is, however, evidence to suggest that becoming distracted may not always be directly related to the choices of the driver, but is instead influenced by the choices of manufacturers, regulators and policy developers (Young & Salmon, 2015; Parnell et al, 2017a). The PARRC (Prioritise, Adapt, Resource, Regulate, Conflict) model of distraction, which focuses on technological sources of distraction (Parnell et al, 2016), takes a systemic view of the phenomenon and proposes that other elements may have a top-down influence in providing conflicting goals to the driver and illustrates how they may be responsible for distraction related accidents. The factors that impact on the decision to engage with potentially distracting tasks is therefore of interest to future accident analysis research, to determine why distraction may be emerging from the system and how it can be managed.

A variety of methods have been applied to the study of driver distraction (Young et al, 2008), from the objective study of what happens when drivers become distracted (e.g. Harbluk et al, 2007) to measures seeking to determine the scale of the problem (e.g. McEvoy et al, 2006). To assess the factors that are impacting on the drivers’ decision to engage with technologies, self-report methods can be used to capture the drivers view of their behaviour (West et al, 1993). Pope et al (2017) explored the drivers self-reported engagement with technologies and contrasted this with a subjective measure of executive functioning in a novel exploration the relation between the two measures. This suggested that increased difficulty in executive functions related to an increased engagement in distractions while driving that could be linked to a lack of ability to inhibit activities. Yet, they noted the need to test the reliability of the self-report methods (Pope et al, 2017).

Online surveys have been used in recent years to understand what distractions drivers engage with as they allow for large scale data collection (e.g. McEvoy et al, 2006; Young & Lenné, 2010; Lansdown, 2012). Such studies have cited the distractions sourced from technologies such as mobile phones, hands-free phones, sat-nav’s and in-vehicle infotainment systems (IVIS) (e.g. Young & Lenné, 2010; Dingus et al, 2006; McEvoy et al, 2006; Harvey et al, 2011). They have provided insights into individual differences (e.g. McEvoy et al, 2006), the perceived risk of drivers when engaging in different tasks and their views on ‘getting caught’ (e.g. Young & Lenné, 2010). The anonymity provided by accessing surveys remotely online may encourage honesty when asking questions that may reveal illegal behaviours characteristic of distraction based research, (e.g. using a mobile phone while driving). Yet, surveys are restrictive in their reliance on closed questions which can facilitate the imposition of the researchers own agenda through their choice of survey questions (O’Cathain & Thomas, 2004). Closed-ended questions, which have been favoured in the literature, limit the driver from detailing the influences they perceive to determine their decision to engage with technologies while driving. To understand *why* drivers become distraction requires the application of the more open-ended methods of qualitative data collection, the use of which have been limited in past research.

Huemer and Vollrath (2011) conducted short interviews with drivers at service stations which probed into their engagement with secondary tasks in their most recent drive. While face-to-face communication of this format allowed drivers to dictate their behaviour in an open manner, the large sample (289 drivers) meant that interviews only lasted 5 minutes and only sought to determine the prevalence of secondary task activity in the most recent trips taken by drivers. The only other research to the authors knowledge that has attempted to probe further into decisions to engage, using in-depth qualitative measures, was a focus group study by Lerner and Boyd, (2005). They conducted focus groups with drivers from different age groups (teen 16-18yrs, young 18-24yrs, middle 25-59yrs and older 60+) to discuss their willingness to engage with a variety of technologies including a sat-nav, mobile phone and a personal digital assistant. They found drivers were primarily concerned with their motivation to perform the task (Lerner & Boyd, 2005). Interestingly, it was found that drivers stated hand-held mobile phone use to be safe to perform under most driving conditions and that they were motivated by social factors such as the use of their personal time. This is in contrast to more recent reports that have identified that drivers rate mobile phone tasks to be high risk and dangerous (e.g. Young & Lenné, 2010). This may be explained by the fact that Lerner and Boyd (2005) conducted their focus groups with participants from Washington D.C in the USA in 2002, where hand-held mobile phone use while driving was not restricted until 2004. Furthermore, the use of focus groups may have facilitated social biases in what participants reveal with normative, cultural and dominance bias playing a role (Smithson, 2000). A more up to date in-depth qualitative analysis is therefore required to understand the decision processes of drivers when faced with modern technologies in the current sociotechnical climate and why they may, or may not, be motivated to engage with distractions.

This paper presents findings from a semi-structured interview study with drivers on their engagement with different technological tasks. It is the first interview based study used to determine the drivers’ views and general usage behaviours relating to a variety of technological distractions, not just mobile phones or the most recent journey. It aimed to understand both *what* technological tasks drivers engage with and *why*. The use of semi-structured interviews has been neglected in the study of driver distraction, yet the interviews conducted within this research enabled drivers to detail their decision-making processes when faced with different technological tasks while driving. To help mitigate the limitations of a smaller sample size, the interview data is supplemented with data from an online survey to assess the representation of the drivers sampled in the interview study to a larger population of drivers. The role of age, gender and roadway environment were explored due to evidence in the literature that suggests these to be prominent factors implicating driver distraction and technology engagement (e.g. Pöysti et al, 2005; Horberry et al 2006; McEvoy et al, 2006; Pope et al, 2017).

# 2. Method

A trade off between the in-depth data analysis of complex open-ended qualitative methods and the sample size had to be made, with lengthy interview data unable to be collected and analysed in great detail from the large samples that may attributed to online surveys. The use of a smaller sample size allows for an in-depth understanding of a small group of participants to explore the reasoning behind their behaviour in greater detail (e.g. Dixon et al, 2017). To determine if the sample in the interview study were representative of those from a larger population, data from the likelihood of engaging ratings in the online survey was used as a comparison. As technological developments are rapid, the use of data collected from UK drivers who are exposed to the same climate of technological development and enforcement of legislation were sought as an acceptable comparison. Although surveys are limited by their inability to infer in-depth knowledge on the drivers’ decision-making process they can be utilised to sample a broader range of UK drivers to determine if the participants use of technology is representative of a broader ranger of drivers. The methods used for both the semi-structured interviews and online survey are detailed below.

## 2.1 Semi-structured interview study

### 2.1.1 Interview participants

Thirty licensed UK drivers were recruited across three age categories (18-30yrs, 31-49yrs, 50-65yrs). These age categories were based on the findings from McEvoy et al (2006) who looked at age effects on engagement with distracting activities using survey methodology. The participant demographics are detailed in Table 1. To be eligible to take part in the study, participants were required to hold a full driving license, have at least 1 year of experience driving on UK roads and drive frequently (on a weekly basis). Due to the sensitive content of the interviews (i.e. declaration of activity that may be considered illegal under UK laws, such as using a mobile phone while driving), confidentiality and anonymity was ensured to allow the participant to talk openly. The interview study was approved by the institutes Ethical Research and Governance Office (ERGO reference: 24937).

Table 1. Interview participant demographic information.

|  |  |  |
| --- | --- | --- |
|  |  | **Age Group** |
| **Demographics**  |  | **Younger** | **Middle** | **Older** |
| Gender  | Female (n) | 5 | 5 | 5 |
|   | Male (n) | 5 | 5 | 5 |
| Age (yrs.) | Mean(SD) | 25.7(2.41) | 36.8(5.43) | 54.9(2.96) |
|   | Range | 22-30 | 31-47 | 51-60 |
| Years since passed test (yrs.) | Mean(SD) | 6.9(2.29) | 16.9(6.82) | 35.1(6.73) |
| Average hours spent driving a week (hrs.) | Mean(SD) | 7.5(3.14) | 12.6(9.27) | 9.3(4.4) |

### 2.1.2 Interview procedure

Interviews lasted between 15-45 minutes (average=34.21mins, SD=14.07), varying on the length of discussions engaged by the participant. The interviews were semi-structured with the central discussion focused on the drivers’ self-reported likelihood of using certain technological devices while driving, and the subsequent effect of road type. Participants were presented with the full version of the table shown in Figure 1, with the UK road types identified by Walker et al (2013) placed along the top (Motorway, Major A/B roads, Urban roads, Rural roads, Residential roads and Junctions) and technological tasks listed down the left-hand side. The technological tasks posed to participants are presented in Table 2, these were drawn from the current literature investigating distraction from in-vehicle technology (e.g. Young & Lenné, 2010; Dingus et al, 2006; McEvoy et al, 2006; Harvey et al, 2011) as well as reports from road safety organisations and police reports (RAC, 2016; Department for Transport, 2015). The tasks were chosen as ones that were frequently reported as distractions, without specific consideration for their duration to complete or their complexity, as it was the decision factors relating to prominently identified distractions that was of interest.

A pilot study evaluated the questions posed to participants to assess the applicability and engagement of the technological tasks under the sociotechnical climate and the UK road type descriptions. This revealed an overlap in some of technological tasks which were subsequently condensed into a final list of tasks (Table 2). It also revealed that drivers reported that they behaved differently when they were stopped at a junction e.g. at a red light, compared to when they were driving through a junction, which substantiated a finding reported by Lerner and Boyd (2005). ‘Junction’ was therefore split to represent both driving through and stopped. Participants were given an information sheet with definitions, descriptions and examples of each road type (based on the discussions in the pilot study) before the interview, to establish a standard understanding of the different UK road types.

Table 2. List of technological tasks that drivers were asked to rate their likelihood of engaging with.

|  |  |
| --- | --- |
| **Technology** | **Task** |
| Navigation system | Monitor route |
| Enter a destination to change route |
| Hands-free communication system | Find number from address book |
| Answer a call |
| Talk on the phone |
| In-vehicle system | Change climate control |
| Change a song/radio station |
| Adjust volume |
| Listen to music |
| Verbally communicate with an in-built system |
| Hand-held mobile phone | Enter a destination into navigation app |
| Monitor navigation app |
| Write/send a text |
| Read a text |
| Answer a phone call |
| Talk on the phone |
| Enter/Find a number |
| Change a song/audio track |
| Use voice assist features |
| Take a photo |
| Use social media apps |
| Check your email |

During the interview, participants were asked to fill in the boxes in Figure 1 by placing a number on a 5-point Likert scale relating to their likelihood of engaging in each of the technological tasks on the left hand side, for each of the road types across the top. 1 on the Likert scale represented ‘extremely unlikely’ and 5 ‘extremely likely’. While filling in the table, participants were also asked to verbalise their thought process and reasoning why they rated themselves to be more or less likely to engage in the task. Participants were encouraged to talk freely and the researcher prompted participants for further information where necessary. Interviews were audio recorded, using an Olympus digital voice recorder, and transcribed.

|  |  |
| --- | --- |
| Task | Road Type |
| Motorway | Major A/B road | Urban Road | Rural Road | Residential Road | Junction |
| Driving | Stopped |
| Navigation System |
| Monitor route |  |  |  |  |  |  |  |
| Enter Destination |  |  |  |  |  |  |  |
| Hands-free phone |
| Enter/find number |  |  |  |  |  |  |  |

Figure 1. Example extract of the table participants were asked to complete during the interview. The actual table contained images depicting the road types that are unable to be resized for inclusion in this paper.

## 2.2 Online survey

### 2.2.1 Online survey participants

A total of 206 participants completed the survey, again they were required to hold a full driving license, at least 1 year of experience driving on UK roads and drive frequently. Their demographic information in presented in Table 3. The online survey was approved by the institutes ethics committee (ERGO reference: 25219).

Table 3. Online survey participant demographic information

|  |  |
| --- | --- |
| **Demographics**  | **Age Group** |
| **Younger** | **Middle** | **Older** |
| Gender  | Female (n) | 35 | 51 | 32 |
|   | Male (n) | 24 | 28 | 34 |
|  | Rather not say (n) | 0 | 0 | 2 |
| Age (yrs.) | Mean(SD) | 25.7 | 40.3 | 57.1 |
|   | Range | 19-30 | 32-49 | 50-75 |
| Years since passed test (yrs.) | Mean(SD) | 7.2(3.2) | 19(7.8) | 36.6(8.6) |
| Average hours spent driving a week (hrs.) | Mean(SD) | 6.5(5.5) | 7.3(4.7) | 7.2(5.1) |

### 2.2.2 Online survey procedure

The online survey was developed using the institutes own ‘isurvey’ platform as part of a larger project into driver distraction from in-vehicle technology. Completion of the full survey took approximately 15 minutes. The survey was designed to explore the drivers’ knowledge and interpretation of driver distraction and the laws surrounding it, as well as their driving tendencies. Importantly, it obtained demographic data from participants and their likelihood ratings for engaging with the same technologies on the same road types as those that were completed by drivers in the interview study. While interview participants were asked to fill in the boxes in Figure 1 by hand, in the online study drivers selected a number from a drop-down list that related to the same 5-point Likert scale as was used in the interviews (1=extremely unlikely, 5=extremely likely). The Likert scale ratings could therefore be compared to the interview ratings. Participants were invited to complete the survey via advertisement posters at the institute and through the social media outlets of the research group.

## 2.3 Data analysis

Only the quantitative Likert scale ratings could be analysed from the online survey. Yet, data collected from the interviews comprised of both quantitative ratings suggesting *what* distractions they would be likely to engage with, and the qualitative reasoning for *why,* detailed in their verbalised decision process. The quantitative ratings between age groups and genders were calculated and aggregated for comparison. The likelihood ratings are given in Section 3.2, with a break down across the younger (Tables 5), middle (Table 6) and older (Table 7) age categories. The small sample size that is attributed to qualitative methods, such as interviews, limits the statistical analysis that could be conducted on the quantitative analysis. It also means that the results should be interpreted with caution.

Analysis of the qualitative data aimed to assess why they rated themselves to be more or less likely to engage across the different task and road types. This utilised the thematic framework developed by Parnell et al (2017b) that was generated from an inductive thematic analysis that identified the key causal factors that drivers suggested influenced their likelihood of engaging with technological tasks, this framework is given in Figure 2. The framework highlights the central role of systemic factors; the driver, infrastructure, task and context, to support the suggestion that factors outside of the driver have a role in error causation (e.g. Stanton & Salmon, 2009; Salmon et al, 2010). It also includes a range of semantic themes relating to the systemic actors that drivers report influence their likelihood of engaging with technologies while driving.

Figure 2. Thematic framework showing the high level and semantic subthemes of causal framework (taken from Parnell et al, 2017b).

|  |  |
| --- | --- |
| **Semantic subthemes**  | **Description** |
| **Driver** | References made by the driver including their mental/physiological state, experience, knowledge, skills, abilities and context-related behaviour |
| **(D1) Attitude of driver** | **Negative:** Reference to negative attitudes of the driver towards performing the task while driving |
| **Positive:** Reference to positive attitudes of the driver towards performing the task while driving |
| **Unnecessary:** Reference to the driver perceiving the task to be unnecessary to perform while driving  |
| **(D2) Tendency** | Reference to the drivers stated tendency to perform the task in the past and/or the future as an indicator of their likelihood to engage |
| **(D3) View of self** | Reference to the drivers stated view of themselves and their own behavioural tendencies when stating their likelihood to perform the task |
| **(D4) Influence of others** | Reference to other people and their influence on the driver and their likelihood of performing the task while driving |
| **Infrastructure**  | Reference to the specific road type within the road transport system, including the layout, contents, policy, and regulated conditions |
| **(I1) Perceptions of surrounding environment** | Reference to the context surrounding the road environment of a specific road type that is interpreted as an influencing factor in the likelihood to perform the task in the specific road environment |
| **(I2) Road Layout** | Reference to features of the specific fixed road environment that influence the driver’s likelihood to perform the task  |
| **(I3) Illegality** | Reference to the legislation on the use of the task while driving  |
| **(I4) Task-road relationship** | Reference to the interaction between features of the road and the task that influence how the two may be compatible such that the likelihood of performing the task is influenced. |
| **(I5) Road related behaviour** | Reference to the actions and responses that are typical or required of the specific road type which influences the likelihood of performing the task on different roads.  |
| **Task** | Reference to the details surrounding the specific task and engagement with it |
| **(T1) Complexity** | Reference to the difficulty or ease of performing the task while driving  |
| **(T2) Interaction** | Reference to physical features of the task that relate to the interaction required to perform the task while driving. This relates to the interface design, device location and driver required actions in order to engage with the task. |
| **(T3) Duration** | Reference to the time and/or length of the task |
| **(T4) Desirability** | Reference to features of the task that influence how desirable it may be to perform while driving. This may include its use, performance or quality and options for alternative methods of completing the task.  |
| **(T5) Engagement regulation** | Reference to the factors that influence the conditions surrounding the onset of the task. They may relate to the physicality’s of the task and/or the drivers’ motivation relating to the task.  |
| **(T6) Ability to complete**  | Reference to features of the task which influence its ability to be completed in full while driving  |
| **Context** | Reference to the circumstances surrounding the behaviour described  |
| **(C1) Journey Context** | Reference to circumstances that form the setting for a journey that may influence the likelihood to perform the task. |
| **(C2) Task Context** | Reference to circumstances that form the setting for the use of the task that influence the drivers’ likelihood to engage with it. |
| **(C3) Road context** | Reference to circumstances that form the setting surrounding the road in general (not related to specific infrastructure) that influence the likelihood to perform the task |

### 2.3.1 Nvivo 11

The interview transcripts were coded to the concepts detailed in the framework (Figure 2) using the software tool Nvivo11, to add rigour to the analysis (Richards & Richards, 1991; Welsh, 2002). The transcripts were input into Nvivo11 and coded to the nodes encompassing the thematic framework in Figure 2, using the sematic themes. The primary researcher coded the transcripts initially by fully immersing themselves in the data set, reading and re-reading the transcripts, before applying the thematic codes. Multiple codes were applied to some aspects of the transcript where it was deemed necessary, in keeping with the method posed by (Braun & Clarke, 2006).

To assess the reliability of the primary researchers’ ratings an inter-rater reliability test was conducted. Following the advice of Boyatzis (1998), two inter raters were selected who were independent to the research project but were familiar with the Nvivo11 software. They were presented with 10% of the transcripts to code and the thematic framework in Figure 2 during a 45 minute briefing session to introduce them to the framework and how to code the transcripts. They used the Nvivo11 software to code the transcripts in the same manner that the primary researcher did. Percentage agreement between the inter raters and the primary researcher was above the 70% deemed by Boyatzis (1998) to be necessary (rater 1= 81.24%, rater 2= 74.87%). This shows the coding of the transcripts to be reliable.

 Nvivo11 also facilitated the running of queries on the coded data to observe the data in both a quantitative and qualitative manner. The distribution of the coded transcript across the themes of the thematic framework between age and gender categories enabled any differences in the reasons drivers, across these categories, gave for their reasons to engage with the technological devices. A matrix query, run in Nvivo11, allowed the number of references to each of the themes across the age/gender category to be calculated. It also enabled the data set to be divide to look at the references to the different technological devices individually. The frequency counts from the matrix queries were calculated as percentages to show the percentage of references to the themes between age and gender categories. These are shown in Table 8-12. This process is detailed in the flow chart in Figure 3.

Step 1. Generate transcripts and import into Nvivo11.

Step 2. Inductively code transcripts in Nvivo11 to develop the thematic framework in Chapter 5, see Figure 2.

Step 3. Perform a matrix coding query in Nvivo11 on the coded transcripts to determine the number of references coded to each key theme. Split by age and gender. Perform this for each technology (sat-nav, hands-free phone, IVIS, verbal communication system, mobile phone).

Step 4. Calculate the percentage of references coded to each theme based on the results of the matrix coding query for all of the age/gender categories and technologies.

Step 5. Highlight the comparative frequency of referenced themes across technologies and genders by producing a heat-map of frequent responses based on the percentages.

Figure 3. Flow chart to demonstrate the steps that were taken to determine the percentage of references to the key concepts from the thematic framework in Figure 2.

# 3. Results and Discussion

## 3.1 Interview and online survey sample comparison

Comparisons between the interview sample and the online survey sample were made. Due to the unequal sample sizes, a non-parametric Mann-Whitney U test was run to compare the demographics from the two samples. This found no significant differences between the age (online survey median=40, interview median=35, U=2783.5, p=0.43), years since passed driving test (online survey median=20, interview median=15, U=2726, p=0.33) or hours spent driving a week (online survey median=7, interview median=4, U=2292, p=0.03; which was non-significant after applying the bonferroni correction for multiple tests). This means that the two samples were comprised of a statistically similar range of participants and credits comparisons that can be made from the small interview sample to the larger online survey sample.

As the demographics of interview sample was found to be representative of the larger interview sample, the relationship between the reported likelihood of engaging with each of the tasks in the online survey sample and the interview sample was explored. This aimed to determine how representative the quantitative findings from the interview sample (n=30) were to a larger sample of UK drivers (n=206). A Spearman’s rank-order correlation was run to identify the relationship between the average likelihood of engaging with each of the 22 tasks (Table 2) on each of the 7 road types. This found a strong positive correlation between the average reported likelihood of engaging with the tasks across the road types between the interview and online survey samples (rs(142)=0.96, p<0.01). This strong positive correlation indicates that the average reported likelihood of engaging with the tasks by the interview participants is highly consistent with the ratings given by the online survey participants, across both task and road type.

## 3.2 Likelihood ratings

Table 5, 6 and 7 present the Likert scale ratings from the interview study averaged within the younger, middle and older age groups respectively, and between genders to present the average likelihood ratings for each category in relation to each road type and technological task. These averaged likelihood ratings are coded with shading to represent the ratings on the Likert scale from ‘extremely likely’ (dark grey) to ‘extremely unlikely’ to engage (white). This generated a heat-map of the responses given by participants to highlight what tasks they were more likely to engage with across participants, grouped by age and gender. Heat mapping is a useful tool in presenting patterns and trends in quantitative data in an easily digestible manner, rather than presenting numerical data alone (Bojko, 2009). Although statistical comparisons cannot be conducted due to the small sample sizes, differences between rated engagement can be seen between technology type, task type, road type, age and gender using the shading on the heat maps.

### 3.2.1 Younger age category

As can be seen from Table 5, younger drivers were more likely to monitor a sat-nav than enter a destination into one, although females were even more likely to monitor a navigational app on their phone. Younger drivers were less likely to find a number than answer a call or talk on a hands-free phone. The IVIS tasks were reported to be the most likely to be engaged with, although they were reported to be less likely when driving through a junction. Younger drivers were more likely to report engaging with mobile phone tasks when stopped at junctions and least likely driving through a junction. They also reported themselves to be moderately likely to engage with numerous phone based tasks while driving across different road types.

Table 5. Likelihood Likert scale ratings for female and male younger age category drivers

|  |  |  |
| --- | --- | --- |
| Task | Younger Females | Younger Males |
| Road Type |
| Motorway | A/B Road | Urban Road | Rural Road | Residential Road | Junction (Drive Through) | Junction (Stop) | Motorway | A/B Road | Urban Road | Rural Road | Residential Road | Junction (Drive Through) | Junction (Stop) |
| Navigation system |
| Monitor route | 4 | 4 | 4.3 | 4.3 | 4 | 3.6 | 3.6 | 3 | 3 | 4.3 | 4.3 | 4 | 3.3 | 4.6 |
| Enter destination | 2 | 1.3 | 3 | 2.3 | 3.3 | 1 | 3.6 | 1 | 1 | 2.3 | 2 | 2.3 | 1 | 2.6 |
| Hands-free system |
| Find number | 1.75 | 1 | 1.25 | 1 | 1.5 | 1 | 1.75 | 2 | 1.3 | 1.3 | 1 | 1.3 | 1.3 | 3.6 |
| Answer a call | 3.5 | 3.25 | 3.25 | 2.75 | 3.5 | 2.75 | 3.75 | 5 | 5 | 5 | 4.3 | 5 | 2.6 | 5 |
| Talk on the phone | 3.75 | 3.75 | 3.5 | 2.75 | 3.75 | 2.75 | 3 | 5 | 5 | 4.3 | 4.3 | 5 | 5 | 5 |
| In-vehicle system |
| Change climate control | 4.75 | 4.75 | 4.5 | 4 | 4.75 | 1.75 | 4.25 | 5 | 5 | 4.8 | 4.6 | 4.8 | 3.8 | 5 |
| Change song/radio station | 5 | 4 | 4.75 | 4.5 | 4.75 | 2.25 | 4.25 | 4.8 | 4.6 | 3.8 | 4.2 | 3.6 | 3 | 4.8 |
| Adjust volume | 5 | 5 | 5 | 4.5 | 5 | 3.25 | 5 | 5 | 5 | 4.8 | 5 | 4.8 | 4.4 | 5 |
| Listen to music | 5 | 5 | 5 | 4.5 | 4.75 | 4.75 | 5 | 5 | 5 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Verbal comms. | 4.5 | 4.25 | 4.5 | 3.75 | 4.5 | 2.5 | 4.75 | 5 | 5 | 4 | 4 | 4.3 | 4 | 5 |
| Hand-held mobile phone |
| Enter destination (nav app) | 2.75 | 2 | 1.5 | 1 | 1.25 | 1 | 3.75 | 2 | 1.4 | 1 | 1.2 | 1 | 1 | 2.8 |
| Monitor route (nav app) | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 2.8 | 2.8 | 3 | 3 | 3 | 3 | 3.6 |
| Write/send a text | 2 | 1.5 | 1.25 | 1 | 1.25 | 1 | 2.75 | 2.4 | 2.2 | 1.4 | 1.2 | 1.4 | 1.2 | 2.6 |
| Read a text | 3.25 | 2.75 | 3 | 2.5 | 3 | 1 | 3.5 | 2.6 | 2.6 | 2 | 2 | 2.2 | 2 | 3.4 |
| Answer a phone call | 3 | 2.5 | 2 | 1.75 | 2 | 1 | 2 | 2.8 | 2.8 | 2 | 2.4 | 2.4 | 2.2 | 2.6 |
| Talk on the phone | 2 | 1.5 | 1.75 | 1.25 | 1.75 | 1 | 1.75 | 2.8 | 2.8 | 2.2 | 2.2 | 2.6 | 2.2 | 2.6 |
| Enter/find a number | 2 | 1.5 | 1.5 | 1.25 | 1.5 | 1 | 2.75 | 2 | 1.8 | 1.4 | 1.2 | 1.4 | 1.2 | 2.6 |
| Change a song/audio track | 3.25 | 2.75 | 2.75 | 2 | 2.5 | 1 | 3.25 | 2.2 | 2 | 1.8 | 1.6 | 1.8 | 1.6 | 2.8 |
| Use voice assist features | 2.75 | 2.25 | 2.5 | 2.25 | 2.5 | 1 | 2.75 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.6 |
| Take a photo | 1 | 1 | 1 | 1 | 1 | 1 | 1.5 | 1.6 | 1.2 | 1 | 1 | 1 | 1 | 1.8 |
| Use social media apps | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1.6 |
| Check your email | 2 | 1.75 | 1.25 | 1 | 1 | 1 | 1.5 | 1.4 | 1.4 | 1 | 1 | 1.2 | 1 | 2.2 |

### 3.2.2. Middle age category

Table 6 shows drivers in the middle age category were more likely to monitor the destination on a navigation system than enter a destination, with females slightly more likely than males. Middle aged female drivers were more likely to answer a call and talk on a hands-free phone than find a number on the device. Males were more equal in their ratings of finding a number and answering a call. Most drivers in the middle age category were likely to engage in tasks associated with the IVIS, apart from the verbal communication systems, which drivers were unlikely to engage with. Males were more likely to interact with a mobile phone than females yet, when stopped at a junction, interactions were rated to be more likely by both genders.

Table 6. Likelihood Likert scale ratings for the female and male middle age category drivers

|  |  |  |
| --- | --- | --- |
| Task | Middle Females | Middle Males |
| Road Type |
| Motorway | A/B Road | Urban Road | Rural Road | Residential Road | Junction (Drive Through) | Junction (Stop) | Motorway | A/B Road | Urban Road | Rural Road | Residential Road | Junction (Drive Through) | Junction (Stop) |
| Navigation system |
| Monitor route | 3.75 | 4.5 | 5 | 4.25 | 4.25 | 4.25 | 3.75 | 2.75 | 3 | 3.75 | 2.75 | 3.5 | 1.5 | 3 |
| Enter a destination | 2.25 | 2.25 | 2 | 2.25 | 1.5 | 1.5 | 3.25 | 2.25 | 2 | 2 | 1.5 | 2 | 1 | 3 |
| Hands-free system |
| Find number from address book | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 3.5 | 3 | 2 | 3 | 1 | 4 |
| Answer a call | 3.6 | 3.6 | 4.6 | 4.6 | 5 | 3.3 | 5 | 4 | 3.5 | 3.5 | 3 | 3 | 2.5 | 5 |
| Talk on the phone | 3.6 | 3.3 | 4.3 | 4.3 | 4.6 | 4 | 5 | 4 | 4.5 | 5 | 3.5 | 4.5 | 4.5 | 5 |
| In-vehicle system |
| Change climate control | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 2.8 | 5 | 5 | 5 | 5 | 4.8 | 4.8 | 3.2 | 5 |
| Change song/radio station | 4.6 | 4.6 | 4.6 | 4.2 | 4.4 | 3 | 5 | 5 | 5 | 4.8 | 4 | 4.6 | 2.6 | 5 |
| Adjust volume | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 3.6 | 5 |
| Listen to music | 5 | 5 | 5 | 5 | 5 | 4.2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Verbal comms. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 1.3 | 2.3 |
| Hand-held mobile phone |
| Enter a destination (nav app) | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1 | 2.4 | 2.8 | 2.8 | 2.6 | 2.4 | 2 | 2 | 3.4 |
| Monitor route (nav app) | 2.4 | 2.4 | 2.6 | 2.4 | 2.4 | 2 | 2.8 | 2.8 | 2.8 | 3.2 | 3 | 3 | 2.4 | 3.4 |
| Write/send a text | 1 | 1 | 1 | 1.2 | 1 | 1 | 1.8 | 1.8 | 1.6 | 1.4 | 1.2 | 1.2 | 1.2 | 3.2 |
| Read a text | 1.4 | 1.8 | 2.2 | 1.6 | 1.6 | 1 | 4 | 3.4 | 3.2 | 3 | 3 | 3 | 2.2 | 4.4 |
| Answer a phone call | 1.8 | 1 | 1.8 | 1 | 1 | 1 | 1 | 3 | 2.8 | 2.6 | 2.6 | 2.6 | 1.2 | 4 |
| Talk on the phone | 1.8 | 1 | 1.8 | 1 | 1 | 1 | 1 | 2.8 | 2.6 | 2.6 | 2.6 | 2.4 | 1.8 | 3.8 |
| Enter/find a number | 1.8 | 1.8 | 1.6 | 1.8 | 2 | 1.6 | 2.8 | 2.8 | 2.6 | 2.4 | 2 | 2.4 | 1.6 | 4 |
| Change a song/audio track | 1.4 | 1.4 | 1.4 | 1.6 | 1.6 | 1 | 1.6 | 2.4 | 2.4 | 2.2 | 2.2 | 1.8 | 1.2 | 2.6 |
| Use voice assist features | 1.8 | 1.8 | 1.6 | 1.8 | 1.4 | 1 | 1.8 | 2.2 | 2.2 | 2.2 | 1.8 | 2.2 | 1.2 | 1.6 |
| Take a photo | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1 | 1.2 | 1 | 1 | 1 | 1 | 1 | 1 | 2.2 |
| Use social media apps | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1 | 2.4 |
| Check your email | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2.2 | 2.2 | 2.2 | 2.2 | 1.8 | 1.8 | 3.6 |

### 3.2.3Older age category

As can be seen from Table 7, older drivers were far more likely to monitor a route on a sat-nav than enter a destination. No older females from the interview sample had access to a hands-free system so there are no results for this technology. Older males, however, were likely to answer a call and talk on a hand-free system. Again, the IVIS task were the most likely to be reported although, similar to the middle age category, they were a lot less likely to use verbal communication systems. The older females were extremely unlikely to use their mobile phone, although they were slightly more inclined to read a text while on a motorway or A/B road. Older males were more likely to use their mobile phone than the females but they were still less likely than all other other age groups.

Table 7. Likelihood Likert scale ratings for the female and male older drivers age category

|  |  |  |
| --- | --- | --- |
| Task | Older Females | Older Males |
| Road Type |
| Motorway | A/B Road | Urban Road | Rural Road | Residential Road | Junction (Drive Through) | Junction (Stop) | Motorway | A/B Road | Urban Road | Rural Road | Residential Road | Junction (Drive Through) | Junction (Stop) |
| Navigation system |
| Monitor route | 3 | 3 | 2.75 | 2.5 | 2.5 | 2.75 | 3.25 | 3.8 | 4 | 4.2 | 4.2 | 4.2 | 2.8 | 4 |
| Enter a destination | 1 | 1.25 | 1.25 | 1 | 1 | 1 | 1 | 1.4 | 1.4 | 1.2 | 1.2 | 1 | 1 | 2 |
| Hands-free system |
| Find number from address book | - | - | - | - | - | - | - | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| Answer a call | - | - | - | - | - | - | - | 3.5 | 3.5 | 3 | 3 | 3 | 3 | 3.5 |
| Talk on the phone | - | - | - | - | - | - | - | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| In-vehicle system |
| Change climate control | 3.8 | 3.8 | 3.6 | 3.6 | 3.6 | 2.8 | 3.6 | 5 | 5 | 4.8 | 4.8 | 4.6 | 3 | 5 |
| Change a song/radio station | 4.4 | 4.2 | 3.8 | 3.6 | 3.4 | 2.6 | 3.4 | 4.6 | 4.6 | 3.6 | 3.6 | 3.6 | 2 | 4.4 |
| Adjust volume | 4 | 4 | 4 | 4 | 3.8 | 3.2 | 3.8 | 5 | 5 | 4.8 | 4.8 | 4.2 | 3.2 | 5 |
| Listen to music | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.4 | 4.4 | 4.4 | 4.4 | 4.2 | 4.4 | 4.4 |
| Verbally comms. | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.3 | 2.3 | 1.6 | 2 | 1.3 | 1 | 2.3 |
| Hand-held mobile phone |
| Enter destination (nav app) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.2 | 1 | 1.6 |
| Monitor route (nav app) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2.8 | 2.8 | 2.6 | 2.6 | 2.2 | 1.8 | 2.6 |
| Write/send a text | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.4 |
| Read a text | 1.4 | 1.2 | 1 | 1 | 1 | 1 | 1 | 1.8 | 1.8 | 1.6 | 1.6 | 1.6 | 1.2 | 2 |
| Answer a phone call | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.6 | 1.6 | 1.4 | 1.4 | 1.4 | 1.4 | 1.6 |
| Talk on the phone | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.6 | 1.6 | 1.4 | 1.4 | 1.4 | 1.4 | 1.6 |
| Enter/find a number | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.2 |
| Change a song/audio track | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.4 | 1.4 | 1.2 | 1.2 | 1 | 1 | 1.2 |
| Use voice assist features | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.4 | 1.4 | 1.2 | 1.2 | 1.4 | 1.2 | 1.4 |
| Take a photo | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Use social media apps | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Check your email | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## 3.3 Likelihood reasoning

The insights from the the drivers’ open ended discussions on why they may be more, or less, likely to engage with the technologies is presented in the following sections. Tables show the percentage ratings that were calculated using the matrix query function in Nvivo11, as detailed in Figure 3. The total number of references to the four main systems themes (Driver, Task, Context, Infrastructure) are aggregated from their comprising subthemes listed below them. Again, heat-map shading has been applied to highlight the different percentage of references to the themes; dark grey indicates a higher frequency of references, white indicates lower frequencyof references to the theme.

### 3.3.1 Sat-nav

The desire to use a sat-nav was discussed, with most participants stating that they would only use the sat-nav if they did not know where they were going, although two participants commented that they use the sat-nav if they do know where they are going as it gives them traffic information and time until arrival. There were some differences in the likelihood of engaging with tasks on the specific sat-nav device, with the young more likely to monitor the navigation app on their phone than use a sat-nav device (Table 5). A shift in the use of smartphone navigation by young people in recent years has been found elsewhere, this has made a link to the heightened confidence young people have in using the technology (Speake, 2015). Yet, when technologies malfunction it can lead to a feeling of loss of control and difficulties in trying to reconnect with the surrounding environment (Speake, 2015).

Despite their increased use for monitoring a route, young drivers were less likely to enter a destination on the phone navigation app compared to entering a destination on the sat-nav device. The laws banning mobile phone interaction while driving may indicate why drivers report a reduced likelihood for this task. Discussion related to the illegality key theme and mobile phones are explored later (section 3.4), but in relation to the sat-nav no references were made by any interviewee to the law surrounding sat-nav use. This could be because there are no specific laws relating to the technology, rather there are generic laws relating to driving with ‘due care and attention’ (see Parnell et al, 2017a).

The discussion with the drivers on their likelihood of engaging with the sat-nav tasks was, for the majority of participants, focused on the road infrastructure. The use of the sat-nav to navigate the road environment is likely to be the reason for this, the only exception was the older males (Table 8). Older males were slightly more concerned with the features of the tasks themselves and largely their interaction with it. For example, one older male commented that they wouldn’t enter a destination into the sat-nav *“because you’ve got to check you’ve spelt it right and then you’ve got to press enter”* (participant 17).This supports previous findings of a reduced ability to cope with managing the increased demand of secondary tasks in older drivers (Alm & Nilsson, 1995; Reed & Green, 1999), adding that older drivers are aware of their difficulties.

The high number of references to the ‘task-road relationship’ theme highlight how drivers change their use of the sat-nav depending on the road environment. For example, *“when I’m on the motorway I’ll sort of look to see when the turning off is and then I just sort of relax after that. I don’t really stare at it”* (participant 13) and *“Residential I would probably be quite likely to do that, again you are crawling along and that is often when you need the sat nav - at the end of the journey”* (participant 1). Previous research has suggested that sat-navs are changing the way in which we navigate (Axon et al, 2012), the egocentric display, in contrast to the objectivity of traditional maps, allow users to only view what is relevant to their journey (Meng, 2004). This has been found to increase the drivers feeling of control (Speake, 2015). The findings from this study suggest that drivers are utilising the egocentric display to only engage with the sat-nav at points within the road environment that they determine to be relevant.

Table 8. Percentage of references to each theme when drivers discussed their likelihood to engage with the sat-nav tasks while driving.

|  |  |  |  |
| --- | --- | --- | --- |
| **Themes** | Young | Middle | Older |
| Female (%) | Male (%) | Female (%) | Male (%)  | Female (%) | Male (%)  |
| Driver  | 6.7 | 0.0 | 16.3 | 2.8 | 15.0 | 10.5 |
| Attitude towards task | 0.0 | 0.0 | 2.0 | 0.0 | 12.5 | 5.3 |
| Influence of others | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| Tendency | 6.7 | 0.0 | 8.2 | 2.8 | 0.0 | 2.6 |
| View of self-behaviour | 0.0 | 0.0 | 4.1 | 0.0 | 2.5 | 2.6 |
| Task  | 33.3 | 42.5 | 28.6 | 22.2 | 25.0 | 44.7 |
| Ability to complete | 0.0 | 0.0 | 2.0 | 0.0 | 10.0 | 2.6 |
| Complexity | 6.7 | 2.5 | 0.0 | 2.8 | 2.5 | 5.3 |
| Desirability | 6.7 | 15.0 | 8.2 | 8.3 | 2.5 | 7.9 |
| Duration | 0.0 | 5.0 | 0.0 | 0.0 | 0.0 | 5.3 |
| Engagement regulation | 6.7 | 12.5 | 10.2 | 2.8 | 5.0 | 7.9 |
| Interaction | 13.3 | 7.5 | 8.2 | 8.3 | 5.0 | 15.8 |
| Context | 6.7 | 2.5 | 4.1 | 11.1 | 7.5 | 7.9 |
| Journey Context | 6.7 | 0.0 | 0.0 | 5.6 | 7.5 | 0.0 |
| Road context | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 |
| Task Context | 0.0 | 2.5 | 4.1 | 5.6 | 0.0 | 5.3 |
| Infrastructure | 53.3 | 55.0 | 51.0 | 63.9 | 52.5 | 36.8 |
| Illegality | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Road layout | 6.7 | 7.5 | 18.4 | 30.6 | 12.5 | 10.5 |
| Road related behaviour | 6.7 | 10.0 | 4.1 | 5.6 | 2.5 | 2.6 |
| Task-road relationship | 33.3 | 35.0 | 18.4 | 19.4 | 30.0 | 21.1 |
| Perceptions of sur. env. | 6.7 | 2.5 | 10.2 | 8.3 | 7.5 | 2.6 |

### 3.3.2. Hands-free phone

As shown in Table 7, no females in the older category owned a hands-free phone so they could not be included in this comparison. Across the other age groups there was a clear distinction between the task ‘find a number’ and the other hands-free tasks; ‘answer a call’ and ‘talk to other’ (Table 5 & 6). This suggests that drivers were less likely to initiate a call by finding a contact, than responding to a phone call and maintaining a conversation. This supports findings from the literature on the distinction between initiating and responding to phone communications, with the desire to respond increased (Atchley et al, 2011; Waddell & Weiner, 2014; Nemme & White, 2010). The exception was the males in the middle age category, where this distinction is less clear and answering a call was reported to be as likely as initiating one. Drivers mostly reported the same likelihood of ‘answering a call’ as ‘talking on the phone’, as one leads to another. Yet, at some points drivers stated that they may delay answering the phone until they were at a point where they felt confident to talk, or they may answer a call but pause the conversation to delay speaking until they confident to do so. For example, *“So I think answering a call is distinctly different to just talking, for the reason that on that rural roads if someone had called me then I’d check to make sure the road is all right before I went to answer the call again. As opposed to if you were on a motorway you’ve got a lot more time to just be able to look at it and then flick back and then pick it up, so you wouldn’t have that kind of delay.”* (participant 4). This supports evidence that drivers are able to adapt their behaviour in line with their perceived demands of the road environment (e.g. Rakauskas et al, 2004; Cnossen et al, 2004; Schömig & Metz, 2013).

Previous research has linked the willingness to engage with phone communications to social factors (e.g. Lerner & Boyd, 2005). The interview responses coded to the thematic framework, however, suggested less of an effect of social pressure in relation to hands-free phone use. The younger drivers, and the middle age category males cited factors relating to the infrastructure to influence their likelihood of engaging with hands-free tasks (Table 9). For the middle aged males these comments were largely focused on the road-related behaviour theme and the task-road relationship, with engagement in the task differing on the features of the road environment that may influence their ability to interact with the task, for example *“You see I actually think urban road, answering a call I’d probably be more likely to than on a major road. I think that might just be because of the driving speeds.”* (participant 7). Younger drivers, who are arguable the most swayed by social pressures in relation to risk taking (Gardner & Steinberg, 2005), cited factors relating to the infrastructure the most in relation to their willingness to engage for example, “*On a motorway,* *you only really have to know when to stop so as long as I know that a car is very, very far ahead of me I can do what I like when that’s happening*” (participant 13). The absence of comments relating to the ‘influence of others’ on hands-free engagement suggest that social factors are less important to young drivers than was suggested for mobile phone communication by Lerner and Boyd (2005).

In line with previous findings related to hand-held phones while driving that suggest older drivers hold stronger disapproving attitudes (Mizenko et al, 2015), the older males were the most likely to report an attitude to the task which influenced their likelihood of engaging, one simply responded, *“I think it’s inherently unsafe*” (participant 8).

Table 9. Percentage of references to each theme when drivers discussed their likelihood to engage with hands-free phone tasks while driving.

|  |  |  |  |
| --- | --- | --- | --- |
| **Themes** | Young | Middle | Older |
| Female (%) | Male (%) | Female (%) | Male (%)  | Female (%) | Male (%)  |
| Driver  | 2.4 | 5.4 | 14.3 | 14.8 | - | 25.0 |
| Attitude towards task | 2.4 | 5.4 | 0.0 | 3.7 | - | 12.5 |
| Influence of others | 0.0 | 0.0 | 0.0 | 0.0 | - | 6.3 |
| Tendency | 0.0 | 0.0 | 14.3 | 11.1 | - | 6.3 |
| View of self-behaviour | 0.0 | 0.0 | 0.0 | 0.0 | - | 0.0 |
| Task  | 24.4 | 29.7 | 50.0 | 18.5 | - | 18.8 |
| Ability to complete | 7.3 | 0.0 | 7.1 | 7.4 | - | 12.5 |
| Complexity | 2.4 | 8.1 | 7.1 | 3.7 | - | 0.0 |
| Desirability | 4.9 | 5.4 | 0.0 | 3.7 | - | 6.3 |
| Duration | 0.0 | 0.0 | 0.0 | 0.0 | - | 0.0 |
| Engagement regulation | 2.4 | 8.1 | 14.3 | 0.0 | - | 0.0 |
| Interaction | 7.3 | 8.1 | 21.4 | 3.7 | - | 0.0 |
| Context | 17.1 | 13.5 | 21.4 | 3.7 | - | 37.5 |
| Journey Context | 2.4 | 2.7 | 0.0 | 0.0 | - | 0.0 |
| Road context | 12.2 | 5.4 | 14.3 | 3.7 | - | 0.0 |
| Task Context | 2.4 | 5.4 | 7.1 | 0.0 | - | 37.5 |
| Infrastructure | 56.1 | 51.4 | 14.3 | 63.0 | - | 18.8 |
| Illegality | 0.0 | 0.0 | 0.0 | 0.0 |   | 0.0 |
| Road layout | 2.4 | 5.4 | 0.0 | 18.5 | - | 6.3 |
| Road related behaviour | 4.9 | 8.1 | 0.0 | 25.9 | - | 6.3 |
| Task-road relationship | 24.4 | 18.9 | 14.3 | 14.8 | - | 6.3 |
| Perceptions of sur. env. | 24.4 | 18.9 | 0.0 | 3.7 | - | 0.0 |

### 3.3.3. IVIS

The IVIS tasks were the most highly rated tasks to be engaged with across all age groups, with most drivers rating themselves to be highly likely to use the system across all road types, except when driving through junctions (Table 5, 6 & 7). Similarly, Lansdown (2012) found that the in-car entertainment system was one of the more frequent activities undertaken by drivers, suggesting that this may be due to the low level of risk associated with these tasks becoming distractors. This is evidenced by one participant from the younger male category stated the following: *“I feel because it’s part of the car, I feel as if it’s okay…it’s as if the car is sort of saying it’s okay to do this so you do just sort of click it and change it up so I’d say a five for all of them”* (participant 13). They make the connection that they felt that the controls located on the IVIS were fine to use because manufacturers have put them there purposefully. This emphasises the responsibility that manufacturers have when placing technologies into vehicles to prevent any unnecessary distraction from the driving task, as drivers are encouraged to interact with features that are built-in to the vehicle.

Indeed, the high ratings of engagement relating to IVIS tasks can be attributed to the comments by participants on the features of the tasks themselves (Table 10). There were multiple comments on the ease of the tasks (‘complexity’ and ‘ability to complete’ themes, Table 10), with pre-programmed buttons for the radio, and steering wheel controls increasing the likelihood that drivers reported for engaging with the IVIS. Many commented that the use of the steering wheel buttons to control tasks, such as changing songs or volume, meant that they could perform the task without looking away from the road, so they were happy to engage in the task most of the time. For example, “*Adjust volume, again I am very likely to. Good news on this I can do it at the steering wheel so I don’t need to look at that, I can just feel it and do it”* (participant 25).

Table 10. Percentage of references to each theme when drivers discussed their likelihood to engage with the IVIS tasks while driving.

|  |  |  |  |
| --- | --- | --- | --- |
| **Themes** | Young | Middle | Older |
| Female (%) | Male (%) | Female (%) | Male (%)  | Female (%) | Male (%)  |
| Driver  | 15.0 | 10.9 | 15.6 | 15.7 | 13.6 | 21.4 |
| Attitude towards task | 8.8 | 5.4 | 0.0 | 7.8 | 5.1 | 11.4 |
| Influence of others | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Tendency | 5.0 | 5.4 | 14.1 | 7.8 | 8.5 | 10.0 |
| View of self-behaviour | 1.3 | 0.0 | 1.6 | 0.0 | 0.0 | 0.0 |
| Task  | 42.5 | 54.3 | 57.8 | 54.9 | 44.1 | 42.9 |
| Ability to complete | 2.5 | 13.0 | 6.3 | 9.8 | 6.8 | 10.0 |
| Complexity | 6.3 | 6.5 | 6.3 | 7.8 | 6.8 | 11.4 |
| Desirability | 6.3 | 9.8 | 14.1 | 7.8 | 3.4 | 4.3 |
| Duration | 2.5 | 0.0 | 1.6 | 0.0 | 1.7 | 0.0 |
| Engagement regulation | 1.3 | 2.2 | 9.4 | 7.8 | 10.2 | 4.3 |
| Interaction | 23.8 | 22.8 | 20.3 | 21.6 | 15.3 | 12.9 |
| Context | 12.5 | 8.7 | 4.7 | 7.8 | 11.9 | 8.6 |
| Journey Context | 0.0 | 2.2 | 0.0 | 0.0 | 3.4 | 0.0 |
| Road context | 10.0 | 6.5 | 3.1 | 5.9 | 6.8 | 7.1 |
| Task Context | 2.5 | 0.0 | 1.6 | 2.0 | 1.7 | 1.4 |
| Infrastructure | 30.0 | 26.1 | 21.9 | 21.6 | 30.5 | 27.1 |
| Illegality | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Road layout | 3.8 | 3.3 | 6.3 | 3.9 | 1.7 | 2.9 |
| Road related behaviour | 3.8 | 0.0 | 3.1 | 5.9 | 8.5 | 2.9 |
| Task-road relationship | 13.8 | 15.2 | 6.3 | 5.9 | 13.6 | 11.4 |
| Perceptions of sur. env. | 8.8 | 7.6 | 6.3 | 5.9 | 6.8 | 10.0 |

The voice command aspect of the IVIS produced markedly different results to the other physical interactions with the system, therefore this was explored separately in more detail.

### 3.3.4 Voice command system

A large distinction in the use of voice command systems was found between those in the younger age category and those in the middle or older age categories (Table 5, 6 & 7). For the younger group, verbal interactions with the in-vehicle system did not differ to their physical interactions with the IVIS, such as changing the radio or adjusting the volume (Table 5). Analysis of the reasoning given by participants highlighted the large number of references to the features of the tasks in relation to the voice system (Table 11). Although all participants reported that features of the task influenced their decision, the younger group were not deterred by any failures of the system and would ‘have a go’ at using it anyway, whereas in the middle and older categories they were more likely to be put off using the voice system as they felt it would not work properly. A young female commented: *“yeah I would probably do that any time as it is just – “just talking”. Although when it doesn’t work and you get annoyed then that is probably more detrimental than anything else.”* (participant 27). Similarly, a young male stated that “*if I get it wrong or don’t complete it, the consequences are minor or irrelevant and I don’t have to take my eyes off the road*.” (participant 5). Whereas an older male commented *“I’ve been in a car where my friend’s been trying to do it and it’s a bit of a joke trying to get the thing to understand you, so I think … I think my car does it, but I haven’t attempted to get it working so extremely unlikely”* (participant 8). Thissuggests that the unreliability of the system prevented them from even attempting to engage with it. This supports previous findings by Lee et al, (2015), who also found that age was inversely related to self-reported technology experience in in-car voice controlled systems and that older drivers were more likely to spend longer trying to perform voice control tasks, finding them difficult to perform and requiring extra prompts. It was therefore evident that voice command technology still has some way to go to gain the trust of the consumer, despite much technological advancement since their conception (Furui, 2010). Further work is required to determine the use of voice command systems from a larger population.

Table 11. Percentage of references to each theme when drivers discussed their likelihood to engage with the voice command tasks while driving.

|  |  |  |  |
| --- | --- | --- | --- |
| **Themes** | Young | Middle | Older |
| Female (%) | Male (%) | Female (%) | Male (%)  | Female (%) | Male (%)  |
| Driver  | 9.1 | 12.5 | 12.5 | 10.5 | 11.1 | 15.8 |
| Attitude towards task | 0.0 | 6.3 | 0.0 | 0.0 | 5.6 | 10.5 |
| Influence of others | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Tendency | 4.5 | 3.1 | 8.3 | 5.3 | 0.0 | 5.3 |
| View of self-behaviour | 4.5 | 3.1 | 4.2 | 5.3 | 5.6 | 0.0 |
| Task  | 81.8 | 84.4 | 75.0 | 84.2 | 88.9 | 78.9 |
| Ability to complete | 9.1 | 6.3 | 0.0 | 0.0 | 11.1 | 0.0 |
| Complexity | 9.1 | 3.1 | 4.2 | 5.3 | 0.0 | 10.5 |
| Desirability | 40.9 | 43.8 | 25.0 | 36.8 | 16.7 | 21.1 |
| Duration | 0.0 | 3.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Engagement regulation | 22.7 | 12.5 | 33.3 | 36.8 | 50.0 | 36.8 |
| Interaction | 0.0 | 15.6 | 12.5 | 5.3 | 11.1 | 10.5 |
| Context | 4.5 | 3.1 | 4.2 | 0.0 | 0.0 | 5.3 |
| Journey Context | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Road context | 4.5 | 3.1 | 4.2 | 0.0 | 0.0 | 5.3 |
| Task Context | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Infrastructure | 4.5 | 0.0 | 8.3 | 5.3 | 0.0 | 0.0 |
| Illegality | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Road layout | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Road related behaviour | 4.5 | 0.0 | 4.2 | 0.0 | 0.0 | 0.0 |
| Task-road relationship | 0.0 | 0.0 | 4.2 | 5.3 | 0.0 | 0.0 |
| Perceptions of sur. env. | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

### 3.3.5 Hand-held mobile phone

Similar to the hands-free phone tasks, the findings from the mobile phone ratings suggest some differences between the initiation behaviours of a phone call i.e. finding a number, and answering a phone call. This distinction was clear in the younger male and female categories (Table 5). The middle age category males showed little differentiation between the two behaviours, suggesting they would be somewhat likely to engage in both initiation and response behaviours across road types, especially when stopped at a junction (Table 6). The older age group reported that they were generally ‘extremely unlikely’ to use their mobile phones, although the males suggested that they may be more likely than the females to read texts and answer/talk on the phone (Table 7).

The age difference observed between the older and the younger age groups may be due to the participants in the older category expressing more difficulty in performing the tasks on the phone, for example: *“Send a text on a hand held device? I can’t do that when I’m stood still in a car park, let alone driving along, so no, no, no, no”* (participant 3). Although another older male did state that they have read a text on the phone, yet they report the adverse effects of doing so e.g*. “Reading a text also seems a bit dangerous to me. But you can … driving, I have done it, but not … I have a … it’s a big dodgy.”* (participant 8). Furthermore, the older age category referenced their attitude towards the mobile phone task considerably more than those in the other age categories (Table 12). The older participants tended to be stronger minded in their views on the use of mobiles phones, leading to the lowest scores for this device (Table 7). One older female commented that the use of her phone related to when she wanted to engage with it, rather than her use being dictated by the person trying to get hold of her: *“the phone is for me, not them. It is having just a bit of attitude!”* (participant 11)*.* While another stated: *“Because nothing is that pressing that it is worth getting yourself killed for, is it? That is the way I look at it. Or killing other people.”* (participant 12). This supports previous research stating that older drivers are more disapproving of mobile phone use when driving than younger drivers and are less likely to use their phone behind the wheel (Mizenko et al, 2015; Lamble et al, 2002). Furthermore, it was the older females who voiced more attitude references to mobile phone use and were the least unlikely group to engage in any mobile phone task (Table 7). Pöysti et al (2005) also found older females to be the least likely to engage with mobile phones while driving and younger males the most likely. This may also explain why the older females in this study did not own a hands-fee mobile phone device.

Conversely, the younger participants stated that they would more readily read a text message as they pop up on the phone screen e.g. *“Yes, I would read a text. It just pops up on your phone. It’s impossible not to really.”* (participant 13). *“I’d definitely see who it was from probably pretty much straight away”* (participant 4). The younger also report the ease of multi-tasking with the mobile phone, in contrast with the comments of the older drivers, e.g. *“If it’s just a couple of words then you can read it quite easily”* (participant 4). This supports previous findings that they may underestimate the adverse effects of the task on their driving performance (Tison et al, 2011). Yet, again rather than being influenced by social influencers (Atchley et al, 2011; Lerner & Boyd, 2005), comments from the interview transcripts in relation to the use of mobile phone's while driving were heavily coded to ‘task’ themes in the thematic framework.

There were numerous discussions on the location of their phone while driving, with drivers stating the importance of this on their interaction with it. Some participants kept their phone in their handbag, others in their pocket while some had phone holders to attach their phone to the dashboard. These were given as reasons for why they may be more or less likely to interact with the phone while driving for example: “*Normally I would leave my phone in my handbag, it automatically connects to the car, so then it would only be if I was stuck in traffic that I would probably get it out and see if there is anything on there*” (participant 22). This is in contrast to another participant “*So it’s clipped to one of my air vents right next to my – in the centre of my car, right next to my steering wheel, so I can glance over and see it better*” (participant 7). The location of the phone had particular relevance to the task of ‘reading a text’. This was the one phone-related task which all participants stated they were more likely to perform than others. Even those in the older age category stated that they would perform this task under some circumstances, with the older females giving the only rating greater than 1 (‘extremely unlikely’, the lowest score on the scale) to the task of reading a text on a motorway and a major road. This highlights the importance of considering where drivers are placing their portable devices in the vehicle.

A new UK road safety campaign has recently started to consider phone location with the tag line ‘make the glove compartment the phone compartment’, guiding the driver away from placing the phone in conflict with the driving task (THINK!, 2017). Yet, this may conflict with the other tasks that drivers use their phone for while driving, such as navigation and music systems. Lerner and Boyd (2005) highlighted the importance of anticipation and preparation for technology use when driving, such as placing technology like Bluetooth earpieces in easy to reach locations while driving to limit distraction.

Table 12. Percentage of references to each theme when drivers discussed their likelihood to engage with hand-held mobile phone tasks while driving.

|  |  |  |  |
| --- | --- | --- | --- |
| **Themes** | Young | Middle | Older |
| Female (%) | Male (%) | Female (%) | Male (%)  | Female (%) | Male (%)  |
| Driver  | 18.1 | 22.1 | 21.4 | 21.9 | 34.3 | 35.6 |
| Attitude towards task | 9.3 | 10.3 | 6.3 | 10.6 | 27.1 | 21.1 |
| Influence of others | 3.1 | 2.3 | 1.9 | 0.7 | 2.9 | 1.1 |
| Tendency | 5.2 | 8.0 | 10.7 | 6.6 | 2.9 | 11.1 |
| View of self-behaviour | 0.5 | 1.4 | 2.5 | 4.0 | 1.4 | 2.2 |
| Task  | 44.6 | 52.1 | 52.9 | 47.7 | 52.9 | 45.6 |
| Ability to complete | 4.7 | 2.8 | 6.3 | 4.0 | 7.1 | 5.6 |
| Complexity | 4.7 | 2.8 | 1.9 | 3.3 | 0.0 | 4.4 |
| Desirability | 13.0 | 18.8 | 14.5 | 13.2 | 8.6 | 13.3 |
| Duration | 2.1 | 6.6 | 1.9 | 0.7 | 1.4 | 0.0 |
| Engagement regulation | 5.7 | 7.0 | 11.3 | 11.9 | 15.7 | 13.3 |
| Interaction | 14.5 | 14.1 | 17.0 | 14.6 | 20.0 | 8.9 |
| Context | 11.4 | 7.0 | 11.9 | 12.6 | 5.7 | 11.1 |
| Journey Context | 1.6 | 1.4 | 0.6 | 0.7 | 1.4 | 0.0 |
| Road context | 2.6 | 1.4 | 1.9 | 1.3 | 0.0 | 1.1 |
| Task Context | 7.3 | 4.2 | 9.4 | 10.6 | 4.3 | 10.0 |
| Infrastructure | 25.9 | 18.8 | 13.8 | 17.9 | 7.1 | 7.8 |
| Illegality | 2.1 | 1.9 | 3.1 | 0.7 | 2.9 | 1.1 |
| Road layout | 7.3 | 0.5 | 1.3 | 6.0 | 1.4 | 1.1 |
| Road related behaviour | 2.6 | 3.8 | 1.9 | 0.7 | 1.4 | 1.1 |
| Task-road relationship | 8.3 | 6.1 | 4.4 | 8.6 | 0.0 | 3.3 |
| Perceptions of sur. env. | 5.7 | 6.6 | 3.1 | 2.0 | 1.4 | 1.1 |

## 3.4 Road type

Drivers reported a total of 462 references to the ‘Infrastructure’ themes across the 30 interviews suggesting the importance of this to the discussions. Yet, the results presented show a greater difference in likelihood ratings between task type than road type, which is consistent with Lerner and Boyd (2005). Yet, Lerner and Boyd (2005) found the effect of road type was more pronounced when they looked at the effect of performing manoeuvres while driving. For example, willingness decreased when exiting and entering a freeway, but increased when stopped at a traffic signal (Lerner & Boyd, 2005). The data presented in this paper suggested a similar pattern. The freedom of the open-ended questions in the semi-structured interviews allowed participants to make their own interpretations of the roadway and their motivations for engaging with the technological tasks. There was a clear distinction, across tasks, between the likelihood of engaging while driving through a junction versus when stopped at a junction (with the exception of listening to music, which is a continuous task that did not alter across the junction). Interviewees were provided with images of the road types, the one corresponding to ‘stopped’ at a junction displayed a traffic light which led participants to discuss the road event as a definite stop, rather than waiting for a gap in the traffic at an intersection. This may suggest the high ratings. Despite UK laws not distinguishing between the use of phones when stopped verses when driving, participants of all ages were more likely to state that they would interact with their phone when stopped at lights or in traffic. The only exception to this was the older females in this sample, who have also been found to be the least likely demographic to use their phone while driving in the literature (Pöysti et al, 2005). Comments such as “*Just because if I’m stopped at a junction I’d have my handbrake on and my car’s stationary so I won’t personally cause a crash”* (participant 7), suggest that these drivers did not view the risks to be as great when the car is stationary. Many stated that if they were stopped that would be when they would ‘have a go’ at doing the task.

The likelihood ratings are varied across the other road types with no clear trends, although there may be some notion that drivers are slightly more likely to engage with tasks on motorways, but this is by no means conclusive and there are inconsistences between tasks and participants therefore further work is required to establish this. The inconsistencies may be due to the various other factors not accounted for such as varying road conditions often found across road types (Horberry et al, 2006), drivers perceived familiarity with the road (Charlton & Starkey, 2011), the journeys they are making when accessing different roads (e.g. longer journeys using motorways) and the confidence of drivers when driving on different road types. Distinctions between the road types on the constructs of drivers’ situational awareness were identified by Walker et al (2013) when drivers were actually driving the roads, rather than talking hypothetically, as they were in the interview study. It would therefore be useful to explore how the drivers’ interpretation of how likely they would be to use the technology when they are actually driving on the road would differ.

## 3.5 Legislation

The ‘Illegality’ theme relates to road safety laws, policy and regulations. It is included under the ‘Infrastructure’ main theme in the thematic framework developed by Parnell et al (2017b), in accordance with other taxonomies (e.g. Stanton & Salmon, 2009; Salmon et al, 2010). The distractive effects of mobile phones have led to the decision to ban their use by drivers across many countries, yet hands-free alternatives are permitted as well as other technologies such sat-navs and in-built IVIS features. There is suggestion that the prohibition of mobile phones may infer that other technologies are comparatively safer to use (Parnell et al, 2017a) and therefore the efficacy of legislation as a distraction mitigation technique has been questioned (Parnell et al, 2017a; Young & Salmon, 2015). There were only 19 references coded to the ‘illegality’ theme, this is small in contrast to 251 references to ‘interaction’ and 95 to ‘task context’. Hence, drivers did not seem overly influenced by legislation when reasoning why they be more or less likely to engage with technological tasks.

# 4. Implications

This study has presented findings from a semi-structured interview study that assessed drivers from different age and gender categories self-reported likelihood of engaging with technological devices, and their reasoning why. With technology becoming increasingly accessible to drivers, they are given more choice in when they can engage with technological tasks. These include task that do not bare any enhancement to the safety of the driving task and may instead be detrimental to it. The findings presented here suggest that drivers do report that they are likely to engage in illegal and distracting activities while driving and the reasons for this are attributed to a multitude of factors. The influence of age and gender have found similar effects as those previously stated in the literature (e.g. Lamble et al, 2002; Pöysti et al, 2005; McEvoy et al, 2006; Pope et al, 2017). The qualitative analysis has, however revealed how drivers discuss the factors that influence their decision to engage with technological tasks. While some drivers, particularly those in the older age category, are able to restrict their use of technological devices while driving, others state they they are quite likely to engage with tasks on their sat-nav, IVIS, hand-free or hand-held mobile phone that may result in them becoming distracted from the driving task. The findings from these discussions has implications for distraction mitigation strategies including those that target actors who can control the interaction with devices (e.g. manufactures, companies, regulators), rather than letting the end user decide (Parnell et al, 2017a).

Sat-nav’s are now commonly used by drivers to navigate, with the ego-centric display allowing the driver to easily find their destination (Speake, 2015). Most drivers within this study said they would only use the sat-nav if they did not know where they were going, although some stated they would use it even if they did know where they were going to update them on the traffic and their time of arrival. This suggests that the utility of the device has extended past the navigation function and drivers are displaying additional navigation information even though they do not require it. The development of navigation apps on mobile phones has also made them more accessible although it was found that drivers tended to state that they were more likely to enter a destination on the sat-nav device than their mobile phone. The lack of references to the illegality theme when discussing sat-nav use suggests that the participants were not aware of the regulations imposed on it, but a number of references were made to the features of the task, with some commenting on the complexity and multiple inputs required to enter a destination.

Previous findings suggest that tasks within the vehicle should take no longer than 15 seconds to complete in total, comprised of segments no longer than 2 seconds (Green, 1999). Yet, evidence that the task of entering a destination while driving takes longer than 15 seconds suggests that the task should be disabled while the vehicle is in motion (Harvey & Stanton, 2013; Parnell et al, 2016). While some participants stated that they would not change a destination while driving, preferring to stop or enter it before they started driving. Other drivers said that they would perform this task while driving and have done so in the past. Manufacturers often display information on the use of the device to the driver when the device is turned on, to warn the user of the potential for distraction and reducing the manufacturers liability for misuse. Yet, a more proactive approach would be to disable tasks that are known to be distracting (Parnell et al, 2016). While some manufacturers do disable some features, including address entry, more regulations across the industry are required to determine which tasks should be prevented from use in motion, or even across certain road environments.

Drivers stated they would be highly likely to engage with the range of facilities within the IVIS. A pertinent comment was made by one participant that they felt it was ok to engage with these tasks as, by placing the technologies within the vehicle, the manufacturer was saying it was ok for them to use them while driving. This further highlights the role that vehicle manufacturers have in facilitating, and prohibiting, distractions within the vehicle. Furthermore, regulations and guidelines on the design and functionality of in-built information systems must ensure manufacturers are only able to place safe and easy to use displays within the vehicle that do not distract the driver. Speech recognition technology offers an alternative way for the driver to interact with in-vehicle technology, using voice commands that do require them to take their hands off the wheel or their eyes of the road. In contrast to manual button press interactions, there was more comments directed towards the desirability and ability to engage with voice command systems. There was a clear distinction in the use of voice command systems between the age categories, which appeared to stem from the drivers trust and views on the reliability of the system. Younger drivers were more keen to have a go at using the system reported, with ratings as high as the other IVIS tasks. While it was evident that the middle and older age group were not confident in the system which limited their use of it. It is clear that the implementation and reliability of the voice command technology has some way to go before its benefits are realised by drivers, particular older drivers who may be more used to traditional ways of interacting.

In line with other conclusions in the literature, younger drivers (e.g. Lamble et al, 2002; Pöysti et al, 2005; McEvoy et al., 2006; Young & Lenné, 2010), and the middle age male group (Engelberg et al, 2015; Pope et al, 2017) reported themselves to be more likely to engage with technologies while driving than the older age group. The older age group were found to differ on their attitudes towards technological tasks and their physical ability to interact with them while driving, further supporting previous findings in the literature (Strayer & Drews et al, 2004; Walsh et al, 2008; Pope et al, 2017). Drivers stated that they would, generally, be more likely to engage with tasks on the hands-free phone than on the hand-held phone. The legislation in the UK that permits the use of hands-free phones but prohibits hand-held mobile phone use may be one reason for this. The bans on mobile phone use propelled the industry to respond with advanced hands-free communication devices that allow drivers to be contactable on the go. Yet, it is now established that hands-free communication is no safer than hand-held mobile phone use (Strayer & Johnston, 2001; Horrey & Wickens, 2006). Despite this evidence, hands-free devices are still permitted and are even readily built-in to modern vehicles by manufacturers that are then actively used by the driver who may not be aware of the increased risk talking on the hands-free phone may cause.

Although drivers do state they would be more likely to use hands-free phone than the hand-held phone, there was still a concerning number of participants, even in the small sample of interview participants, who claimed they would be likely to engage with their hand-held mobile phone while driving. The claims by these drivers provides evidence for the argument that the use of penalties and fines enforcing the ban on mobile phones in the UK are inadequate. Many countries have increased penalties for young or novice drivers that aim to target this high risk population, yet the results of this study, and others (e.g. Young & Salmon, 2015; Parnell et al, 2017a), suggest that the law alone is not enough. Therefore, it is recommended that alternative, systemic, measures for targeting the use of technologies by younger drivers be explored further. For example, young drivers engaged in a lot of discussion on the features of the tasks, their interaction with them and the ease of doing so, in contrast to older drivers. Therefore, this aspect of technology interaction should be investigated for practical strategies to prevent distraction.

Reading text messages was the task that drivers from all age groups rated they would be more likely to engage with than other hand-held mobile phone tasks. The authors argue that the reactional nature of this task is what affords this higher rating, with many drivers commenting that they are often alerted to the text by a tone or it flashing up on their phone, which catches their attention and encourages them to then read the text or see who it is from. This therefore questions the responsibility of phone manufacturers who permit such interactions with drivers. The technology is available to impose phone applications that freeze phone interactions while driving but they are not in widespread use. Phone manufacturers currently have no obligation to cater for phone functionality while driving, advocates of a more systemic approach to safety state that this should change (e.g. Young & Salmon, 2015; Parnell et al, 2017a). Furthermore, as drivers are increasingly using their mobile phones for multiple functionalities while driving, such as music players and navigational aids, phone manufacturers need to be aware of how their devices are influencing the driving task and their potential to cause distraction related accidents.

The possibility of phone multi-functionality when driving also influences where drivers choose to position their phone. Many of those who stated they use their phone for navigational purposes fix their phone to the vehicle in a position that is easy to see. Aftermarket manufacturers have developed fixings for this purpose inline with the UK law that bans any hand-held interactions with the phone but does not prohibit the placement of the phone in the drivers’ line of sight as long as it is fixed to the vehicle. Drivers are therefore more likely to be alerted to text messages and incoming phone calls, increasing temptation to engage with them. This further highlights the workarounds that occur when legislation specifically bans certain tasks that can can then lead to further issues, rather than resolving existing ones (Parnell et al, 2017a). Distraction mitigation strategies need to be aware of these issues and the desire for multi-functionalities of smartphones, such as navigation assistance which are not specifically banned for use while driving.

Across the majority of the tasks presented, drivers of all age groups tended to report that they are more likely to engage with technologies when stopped at a junction e.g. at a red light, and less likely when they are driving through a junction. This suggests that drivers do adjust their decision to engage in line with the demands of the environment. Participants generally perceived the consequences of their actions to be reduced if they were not performing the act of ‘driving’. Yet, engaging with distracting tasks is still prohibited when stopped in traffic or at a red light as drivers need to be alert and aware of other traffic at all times. Statistics from a naturalistic study support this finding with double the percentage of drivers observed to be using their phones when stopped in traffic than when driving (Department for Transport, 2017). If the highway code and road safety laws that aim to regulate the use of portable hand-held devices while driving are to be optimised, the distinction that drivers currently make between being in-motion and stationary needs to be questioned. Alternatively, approaches such as those taken in Sweden could be adopted which permit the use of technologies, including mobile phones, by drivers as long as they do not engage in activity that may be ‘detrimental’ to their driving. This encourages the driver to take responsibility for when they choose to engage with technologies and reduces any persuasion that some technologies that are not banned, or that are built in to the vehice, are safer than others that are banned (Parnell et al, 2017b). Sweden’s alternative road safety approach has already seen reductions in the number of fatality rates attributed to the road transport domain (Johansson, 2009). Although, its application to other countries road transport systems would need a significant amount of further research to assess its advantages.

### 4.1 Limitations and future work

The qualitative interpretation of the quantitative ratings has allowed the exploration of the prevalence of key concepts that were discussed by drivers of different age and genders towards different technology types. Within the semi-structured interview study a trade off was made between gathering in-depth qualitative data for an in-depth analysis and sample size. The limited sample means that caution should be taken in the interpretation and generalisations made between the data and the wider driving population, particularly when looking at the gender effects. Future research should seek to explore the qualitative themes generated to a larger population of drivers. Additionally, the findings are limited by the self-report methodology, future research should seek to research these concepts within realistic driving conditions. Ethical considerations surrounding driver distraction research can prevent the researchers from capturing drivers’ physical engagement with distractions under real-world conditions (Young et al, 2008). Yet, asking drivers to verbalise their willingness to engage with distractions in simulated and naturalistic driving environments is an interesting avenue for future research.

# 5. Conclusion

An understanding of why distraction related accidents occur has been under-researched. This paper highlights the importance of understanding the reasons behind the behaviour in order to propose effective countermeasures. The novel application of semi-structured interviews has generated both quantitative data to understand *what* tasks drivers were likely to engage with and qualitative data to propose the reasons *why*. Correlations of the quantitative data to a larger sample of drivers suggests that the findings are representative of drivers outside of those sampled. The use of the Nvivo 11 software to code the interview transcripts to the thematic framework developed by Parnell et al (2017b) permitted quantitative analysis of the qualitative data set in the form of a matrix query to identify what key concepts were discussed by the participants in relation to the different technologies. The qualitative interpretation of the quantitative ratings has allowed the exploration of the prevalence of key concepts that were discussed by drivers of different age and genders towards different technology types. The findings have shown support for previous age and gender differences in what tasks are engaged with, as well as suggesting how these differences arise due to the themes that drivers of different demographic groups discuss in their reasoning why. Although, due to a trade off between in-depth qualitative analysis and sample size, the interview sample size is small in-contrast to that which can be recruited with surveys, data should therefore be interpreted with caution.

Areas for concern include the points where drivers think it is acceptable to engage with technologies, such as when stopped in traffic. The location of portable devices was also highlighted as highly variable across drivers. This has been under reported in the past, yet, results presented here found it to influence how likely drivers were to engage with tasks on the device, especially reactional tasks like reading a text message. The use of mobile phones is also heavily interlinked with their multi-functionality and the high level of participants who report using their phone as a sat-nav which increases their interaction with the device while driving. To prevent distraction occurring from these sources it is suggested that manufacturers of portable devices and in-built technologies, including sat-nav’s, information systems and hands-free devices, should take more responsibility over the use of their devices at in-appropriate times, such as when driving. Moreover, it was also highlighted that the high use of IVIS tasks may relate to the perceived safety of completing these tasks as they are designed for use while driving. Therefore, manufacturers should account for this when designing driver interfaces. A more proactive approach is needed that prevents high risk decisions from being left to the control of the end user.

# 6. Acknowledgements

This research was funded by the Engineering and Physical Science Research Council (EPSRC) grant EP/G036896/1 and industrial sponsor Jaguar Land Rover, under the Industry Doctoral Training Centre in Transport and the Environment.

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