A naturalistic study of mobile phone distraction during driving: An analysis of the UDRIVE project database

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<u>Authored by:</u>

Daryl Hibberd

Zahara Batool

Oliver Carsten

Rashed Ismaeel

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UNIVERSITY OF LEEDS

ARUP AECOM

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Executive summary

Naturalistic driving studies are a research method used to provide insight into driver behaviour during everyday trips. A driver's vehicle is equipped with data logging equipment and video cameras. Data is gathered continuously over a prolonged period without any intervention or instruction from the research team.

UDRIVE was the first major European naturalistic driving study. The project involved two years of data collection (Summer 2015 to Summer 2017) across six European countries (UK, Germany, the Netherlands, France, Poland and Spain) and three vehicle types (passenger cars, trucks and powered two wheelers). The 192 car participants were from the UK, Germany, the Netherlands, France and Poland, all driving their own vehicles. In the UK, drivers were recruited from two operation sites in Leeds and Loughborough. All drivers drove a Renault Clio 3, Renault Clio 4 or Renault Mégane hatchback.

This project has used the naturalistic driving database from the UDRIVE project to obtain a deeper understanding of drivers' use of their mobile phones, and to gain insight into why, how, when and what contexts mobile phones are used whilst driving. Fifty-one UK drivers participated in the UDRIVE data collection, driving their own vehicles for up to 21 months, with a total of 13,962 hours of driving, over 60,140 trips. The data recorded from the trips included seven camera views, vehicle controller area network (CAN) data (providing a live stream of real time vehicle control and sensor information), GPS position (subsequently map-matched for road type and speed limit), relative position to vehicles and other road users in the forward scene from an image-processing system and questionnaire responses from each participant on their attitudes and driving behaviour.

The UDRIVE data collection did not automatically code non-driving related activities such as mobile phone use. Thus, it was necessary to use manual coding from video playback of trips to identify such activity. For the work reported here, a sample of 765 trips across the UK drivers has been used. Some of the coding was done within the original UDRIVE project, but for this study the sample of trips has been greatly expanded. Approximately 15 trips per driver have been coded, providing a considerable dataset for analysis. Mobile phone interaction has been coded in detail, e.g. for dialling by hand or speaking hands-free, interactions with the phone not involving conversation, and simply holding the phone ready for use. (The video streams used for coding do not include sound, and therefore hands-free phone use frequency may be higher than that observed in the sample).

Almost all the UK drivers in the sample engaged in some form of non-driving activity in one or more of their trips. As regards mobile phone use, 69% of the drivers had at least one interaction with a mobile phone while driving; thus, over two-thirds of the drivers in the sample used a mobile phone at some point. On the other hand, 85% of the trips involved no mobile phone use. Nevertheless, usage was quite heavy on a small number of trips and some drivers used their phones on virtually every trip. Drivers interacted with their phone in a variety of ways, both handheld and hands-free. Only a small minority (38 in total) of interactions with mobile phones were completely hands-free. Over 600 interactions were visual or visual-manual, which is problematic from a safety perspective. On the other hand, hands-free interaction tended to have substantially longer duration: the mean time duration of a hands-free call was more than three times that of a handheld call. However, all phone calls were rare (only 21 were observed in total, counting both handheld and hands-free calls).

Caution should be applied before generalising this trend to a wider population, given that the UK driver sample size is small (n=51) and few calls were made or received, making it difficult to draw strong conclusions on behavioural trends. Future work should look to identify a larger sample of phone call cases to establish whether this trend is observed more widely.

Many drivers engaged in a variety of handheld interactions with a phone that was not retained in a cradle. Some of these interactions occurred with durations more than 25 seconds, speeds of over 50 mph, and a short time-to-collision to the vehicle in front, therefore creating potentially safety-critical situations. Almost all calls, including hands-free calls were initiated with a manual interaction with the phone itself. The majority of these were not with a phone held in a cradle, suggesting some degree of misunderstanding or apathy towards current UK regulations relating to handheld phone use. There may be room for improvement in driver education about what types of mobile phone use are deemed unsafe and not covered by current regulations.

Mobile phone use was spread across different lighting conditions, road conditions (wet or dry) and road type. Drivers in the sample tended to use their phones less in darkness, especially when there was no surrounding street lighting. Passenger presence reduced propensity to have a mobile phone conversation. Drivers in the sample rarely used their phone in the presence of passengers for any task, with only 53 phone interactions (8%) occurring with a passenger present in the vehicle, despite a passenger being presented in nearly one-third of trips (32%). Drivers in the sample who used their phone tended to keep their phones close by — on the passenger seat, on their own seat or lap or near the gearshift in the centre. In only a minority of cases, did they have the phone in a cradle.

The observations suggest some indication of adapting to driving circumstance with more phone activity occurring while stopped or travelling at low speed but nevertheless maximum speeds of over 70 mph were occasionally observed for both hands-free and handheld conversations. All activities were more likely when the vehicle was stationary. This was especially pronounced for handheld interactions, which were more likely to occur when stationary. However, the interactions still occurred more when the vehicle was moving, due to the low proportion of time that drivers spend stationary during a typical drive. In passing through an intersection (an at-grade junction or roundabout), activity was reduced while in the intersection itself, as opposed to the approach (upstream) and exit (downstream) phases. This effect was particularly strong for handheld interactions. There was also a far greater propensity for such interaction while stopped than while moving.

We conducted a cluster analysis of the personality and attitudinal questionnaire administered to the drivers to ascertain whether personality and attitudes were related to mobile phone interaction. Three distinct clusters of the UK drivers emerged. One cluster, which had a lower tendency to blame crash involvement on the actions of others or on fate and saw crashes as being caused by multiple factors, had generally less handheld use of a mobile phone. The other two groups, with greater handheld use, saw crashes as being caused more by the actions of others or by the combination of the actions of others, fate or vehicle and environment factors. Overall propensity to take risks was higher in these two clusters, indicating that such an attitude may be a likely factor in willingness to use a handheld phone while driving.

We conducted detailed individual case studies, focussed on trips with extensive usage of mobile phones. These studies revealed some alarming behaviours, e.g. where phone usage did not adapt to changes in the traffic situation of the road environment, where the phone was used while being held very low, perhaps to avoid detection, where two phones were being used simultaneously, and where a phone was dropped into the foot-well and then retrieved whilst the individual was still driving. Overall, the example drives examined in the case studies showed that having a phone nearby seems to lead to frequent interaction in the shape of glancing or picking the phone up to check it.

The report findings suggest some themes for media campaigns. One is that keeping a mobile phone out of easy reach — in a handbag, pocket or the glove compartment — may reduce the temptation to use it while driving. The observations suggest that some drivers are not able to resist frequent checking when the phone is nearby, and they will also respond to being called and be tempted to make calls.

In terms of enforcement, it appears that some drivers are using the strategy of keeping their phones low down, below the level of the car window, presumably in the hope that this will reduce the risk of detection when using the phone for calling or some other form of communication involving physical interaction. Thus, there may be an unintended consequence of the current law that is detrimental to safe driving.

Given the personality findings, the issue of responsibility could be a focus in campaigning. Drivers in the sample who attributed more responsibility for accidents to other drivers tended to use their phones more, especially handheld. There are also were also links between phone use and self-reported sensation-seeking or risk-taking propensity, meaning that risk-takers may also be a driver group to target with education or campaigns to reduce phone use during driving.

1. Introduction

The Department for Transport (DfT) commissioned the University of Leeds and AECOM to conduct an investigative study into mobile phone use during driving using a naturalistic driving database to obtain a deeper understanding of a sample of drivers' use of their mobile phones, and to gain insight into why, how, when and what contexts mobile phones are used whilst driving. This insight can inform attempts to tackle mobile phone use by drivers on UK roads, including contributing to the development of interventions or campaigns targeted towards specific groups of drivers or environmental conditions. Research questions were developed through discussion with a wider stakeholder group, including Dr Helen Wells of Keele University, the RAC Foundation, the National Police Chiefs Council, Highways England, and DVLA. They focussed on topics such as prevalence of phone use, detailed phone sub-task analysis and the environmental and driver personality factors that influence the occurrence and cessation of these phone use activities. The work uses extensive coding and analysis of video footage captured during driving trips. Where numbers and breakdowns are presented, they should not be assumed to be representative of UK drivers or driving.

1.1 What is naturalistic driving?

Naturalistic driving is a research method used to provide insight into **driver behaviour during everyday trips**. It is a widely used methodology that has been employed in the UK and Europe (UDRIVE project, Castermans, 2017), the USA (SHRP2, Campbell, 2012; 100-car Naturalistic Driving Study, Neale et al., 2002), and Australia (Australian 400-car Naturalistic Driving Study, UNSW, 2019).

A driver's vehicle is equipped with **data logging equipment and video cameras**. Data is gathered continuously over a prolonged period **without any intervention** or instruction from the research team.

The data collected includes information about vehicle movements (speed, acceleration, position in lane), vehicle operation (indicator and headlight operation, seat belt use) driver behaviour (head, hand and foot movements), the surroundings (traffic, weather conditions, time of day, gap to other vehicles) and location (GPS). This is often supplemented by extensive socio-demographic data on the driver themselves, including age, gender, personality, driving experience, and driving history.

The advantage of this data collection method is that it provides the opportunity for **prolonged, unobtrusive observation** of drivers in their natural setting. The detail contained within the data allows an **in-depth study of real-world behaviours and the prevailing factors that cause or contribute to them**.

For example, we can find and analyse the situations in which an individual driver chooses to interact with their mobile phone, the environmental conditions preceding, during and after it, and any relationship between self-reported driver type or personality.

The naturalistic driving database collected in the European UDRIVE project (http://www.udrive.eu/) provides a unique opportunity to study a sample of drivers' interaction with mobile phone tasks. Driver distraction, and in particular, various activities carried out on mobile phones while driving, is a well-known safety problem (see e.g. the review by Kircher et al., 2011 and that of Carsten and

Merat, 2015) and is already the target of enforcement in the UK. The database allows detailed investigation of mobile phone usage, with the ability to ascertain who is doing it, precisely what they are doing (e.g. talking or texting), where and in what circumstances they are doing it, and even what motivates them to end their mobile phone activity. To some extent, these issues were covered in the relevant UDRIVE deliverable (Carsten et al., 2017; https://erticonetwork.com/wp-content/uploads/2017/12/UDRIVE-D43.1-Driver-distraction-and-inattention.pdf), albeit with a smaller sample of drivers, across all European countries with passenger car data. This current report investigates the usage in far more detail and does so with an expanded database of cases annotated for mobile phone usage. Furthermore, this report focuses primarily on the UK drivers' use of mobile phones, with some comparisons drawn with other countries.

1.2 Research questions

This project sought to investigate the prevalence of secondary task interaction, specifically mobile phone use, and the factors linked to its occurrence. This work focuses in detail on the sub-tasks involved in mobile phone use behind the wheel, and how, why and when a sample of drivers choose to do them. The research questions to be answered were:

- What is the influence of environment conditions, demographics and personality on phone use?
- In what circumstances do individuals **initiate** mobile phone use? E.g. type of road, time of day, type of manoeuvre, presence of passengers?
- Is there a blurred line between **legal** and **illegal** use?
- Where do drivers keep their mobile phones?
- Does usage have detrimental effects on **driving performance**?
- Is mobile phone use **habitual** (e.g. picking up phone when message is received) or more **planned** (e.g. dialling)?
- What makes people **stop** using their mobile phones?
- How does phone use compare between **countries**?

1.3 The UDRIVE project

UDRIVE (http://www.udrive.eu/) was a collaboration of 18 partners to collect and analyse naturalistic driving data for cars, trucks and powered two-wheelers. Data was collected continuously over a period of at least a year per vehicle using state-of-the art data acquisition systems. The project deliverables can be found at http://www.udrive.eu/index.php/udrive-library/deliverables and include Deliverable 43.1, Driver Distraction and Inattention (work led by the University of Leeds).

The total database size is approximately 61 TB. The number of trips and hours of driving is shown in Table 1. For the car driver sample, the UK has the largest number of drivers and trips.

Table 1: The number of drivers or riders per country in the UDRIVE database. The numbers of trips and hours of driving per country is listed, along with the vehicle type involved in data collection.

Vehicle Type	Country	Number of drivers or riders	Number of trips	Number of hours of driving
	Germany	27	23,499	5,338
	France	43	49,878	12,635
	Netherlands	33	13,434	17,204
	Poland	31	27,954	7,544
	UK	51	60,140	13,962
	Netherlands	48	89,366	17,204
	Spain	47	7,487	891
	Total	**281**	**271,758**	**61,405**

The data from the vehicles includes (Figure 1):

1. Multi-channel video, of both the external scene and of the interior, including the driver's face
2. CAN (vehicle network data), such as speed, gear, pedal position
3. GPS position
4. Derived data from a Mobileye image sensor, indicating the relative position of up to three objects in the forward field of view

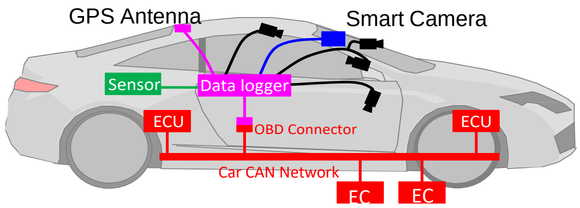

Figure 1: UDRIVE vehicle data collection network including cameras, data logger and GPS antenna.

In addition, there is map-based data, derived from map-matching of GPS position. Finally, there is also questionnaire data from the participants, covering personality, attitudes, etc. This last is in a separate set of tables, linkable to the main data by driver ID.

The video data is particularly relevant to this work. Seven camera views offer a 300° external view and interior views of the cabin, driver face, and hand and feet actions (see Figure 2). The over-the-shoulder camera gives a view of driver activity, while the face camera allows interpretation of head movement and visual attention.

Figure 2: UDRIVE vehicle camera views. Note that the individual shown is a member of the project team and has given permission to share this image.

2. Coding and analysis methodology for this task

Coding involves a process of repeated viewing of the recorded video streams, identifying events of interest using a pre-defined coding scheme, and then cross-checking data quality across multiple viewers.

765 UK driver trips were coded for driver secondary task activities (e.g. any activity not required to successfully complete the primary driving task such as eating, smoking, using a mobile phone).

Each driver was sampled equally (51 drivers, 15 trips each), with all trips within an individual driver being sampled at random. Coding of secondary task interaction only occurred if all cameras were functional for the full trip and oriented appropriately to allow a view of the required interior or exterior location. Continuous and time-synchronised vehicle metrics were also required.

The total number of trips coded was decided based on available time and budget and the required sample size for a robust qualitative analysis.

2.1 Full trip coding approach

The coding process involved a three 'pass' approach to data collection. A pass refers to a complete viewing of the seven video streams recorded for a trip, either from start to end (or in the case of the second and third passes, for a specific mobile phone task duration). The first pass was used for identifying and categorising all types of secondary task interaction, the second for detailed measurement of mobile phone sub-task interaction, and the third for recording the environmental conditions during all mobile phone interactions. More detail on the process is present in Table 2 (and Appendix C).

Handheld interaction was coded as any physical contact with the phone, regardless of whether the phone is being held in the hand, a phone cradle or resting on the seat or another part of the driver's body. In the analysis, a distinction was made so that the illegal handheld use of the phone (i.e. that in which the phone is used whilst physical held in the hand) can be identified. This can be seen in the further sub-categorisation of this mobile phone sub-task into handheld interaction *hand,* handheld interaction *seat or lap,* and handheld interaction *cradle*.

To address the research question focusing on the impact of demographics on phone use, we compared phone use in each European country with passenger car data in the UDRIVE project (though no records were coded from the Dutch dataset due to late delivery to the central database). The coding of non-UK trips was conducted as part of the UDRIVE project using the same coding schemes as described above. This provided a further 120.1 hours of driving data coded for phone use for comparison with UK drivers in the sample. A summary of this data is presented in Table 3.

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Table 2: Secondary task coding process, detailing the type of tasks to code during Pass A, B and C, and how to identify task start and end points.

Pass	Description of coding approach
A	Global annotation of secondary tasks. This pass focussed on coding the whole trip selected for secondary task activity, with tasks being defined in broad categories including: mobile phone, electronic device, food and drink, smoking, personal grooming, talking and singing, and other.
B	Detailed coding of mobile-phone sub-tasks. Each segment of the trip that contained a mobile phone interaction was viewed a second time to observe the specific actions the driver performed while interacting with their mobile phone. These categories included: searching for the phone, handheld and hands-free conversation, handheld and hands-free interaction, holding the phone, reading from the phone, and other phone-related actions. Start and end points of each sub-task were recorded to the nearest 0.1 second interval. For hands-free actions, this involved the first/last eye movement or mouth movement of the task. For handheld sub-tasks, this involved the first/last physical contact with the phone. For example: **handheld interaction** The driver is pressing buttons or a touch screen on the phone. The driver can be writing a text message, browsing the internet, or interacting with other phone applications. These are mainly physical interactions (e.g. with finger) that will alternate with small pauses (i.e. looking back to the road). The time is recorded from the first contact with the phone screen until the final contact. A new task is started if there is a gap of more than 10s between consecutive touches of the phone screen. There is no minimum task duration, with any interaction being coded and included in the dataset for analysis.
C	Environment coding. Each segment of the trip that contained a mobile phone interaction was viewed a third time, with recording of key environmental variables during phone use. The following variables were coded at the onset of a mobile phone sub-task: weather, road surface, light conditions, time of day, presence of an intersection (or junction, such as T-junction, crossroads, roundabouts), and presence of passengers in the vehicle.

Table 3: The number of trips annotated for secondary task interaction by country in the UDRIVE database.

Country	Total number of trips	Total travelled time (hours)	Total travelled distance (miles)
France	217	58.5	1790
Germany	83	20.2	781
Poland	150	41.4	1044
United Kingdom	765	191.4	5459

2.2 Intersection coding approach

A further sample of data has been analysed focussing on driver performance at intersections. Intersections refer to an at-grade junction where multiple roads intersect including junctions where the driver has priority and does not need to stop, junctions where the driver does not have priority, and roundabouts. These can be both un-signalised and signal-controlled.

This work included drivers from the full European passenger car sample. For the 163 drivers who had made at least 20 trips, we selected 10 trips at random (minimum trip length = 1km). Within each trip, one intersection was randomly selected for coding using the three-pass coding approach described above in Table 2. 1630 intersection cases were coded. It should be noted that, for these cases, coding does not cover the entire secondary task interaction, if it commences before the intersection or continues beyond it. The proportion of the total driving time through an intersection where the driver was performing a secondary task was recorded. This was further broken down into before, during and after intersection stages. It was also noted whether the vehicle was stationary at any point when a secondary task was performed.

2.3 Case studies

To complement the statistical analysis, a set of case studies of individual trips was undertaken. The motivation was that the detail afforded by the more descriptive approach would allow further insight into the circumstances and even the motivation behind mobile phone use. The cases selected all had a significant amount of mobile phone activity during the trip. In that sense, they are not typical of the whole sample, but they may well typify the behaviour of those UK drivers who are more prone to substantial mobile phone use while driving, and who thus feel motivated to disregard the changes in the legality and consequent penalties for mobile phone use.

3. Analysis

This section reports on mobile phone use in the UK sample of 51 drivers (26 females, 25 males). 15 trip records per driver have been annotated for secondary task involvement as per the annotation process detailed in Appendix C. In the 765 trips coded, 662 distinct mobile interactions were observed in 111 trips (15% of the UK trips coded).

3.1 Secondary task prevalence in the UK driver sample

3.1.1 All secondary tasks

There was evidence of considerable variation in secondary task interaction between drivers in the sample. Most drivers are willing to engage in secondary tasks. However, a small proportion of the sample did not divert their attention from the driving task at all.

In the UK sample, there was a range of different types of secondary task observed during driving, with nearly three-quarters of the trips viewed containing at least one secondary task interaction (73%). Almost all drivers (92%) engaged in a non-driving-related task in at least one out of the 15 trips coded for them, showing that distraction from the driving task is a frequent and common occurrence. **Mobile phone use was the most common secondary task in terms of proportion of drivers engaging with it (69%).** Over half of drivers were observed to talk with a passenger or sing during at least one trip. A large proportion of drivers were also observed to consume food or drink and perform personal grooming activities (Table 4).

Smoking was rarely observed in our sample; however, it had the longest mean duration for any secondary task. Food and drink consumption and personal grooming activities were the shortest duration distractions, both on average and in terms of maximum time for a single interaction. The use of an electronic device other than a mobile phone was rare.

Table 4: Secondary task interaction in the UK sample of 51 drivers from the UDRIVE project. This table shows the number of drivers who did each mobile phone sub-task and the mean, median and maximum duration for that sub-task.

Task	Percentage of drivers observed (%)	Mean duration (s)	Median duration (s)	Maximum duration (s)
Mobile phone	69 (35 out of 51)	118	27	2657
Electronic device	12 (6 out of 51)	129	23	1016
Food and drink	49 (25 out of 51)	60	20	996
Smoking	6 (3 out of 51)	456	400	3423
Personal grooming	41 (21 out of 51)	48	18	659
Talking or singing	51 (26 out of 51)	104	36	1933

Table 5: Secondary task interaction per driver. Each row represents one driver in the UK sample. Grey squares mean that a driver has performed a secondary task as a single task. Blue squares mean that a driver has performed multiple secondary tasks at the same time.

Mobile phone	Electronic device	Food and drink	Smoking	Personal grooming	Talking/singing	Total Task Types	Dual-tasking
Grey		Grey	Grey	Grey	Grey	**5**	Blue
Grey	Grey	Grey		Grey	Grey	**5**	
Grey		Grey		Grey	Grey	**4**	
Grey	Grey	Grey		Grey		**4**	
Grey	Grey	Grey	Grey			**4**	Blue
Grey		Grey		Grey	Grey	**4**	
Grey		Grey		Grey	Grey	**4**	
Grey		Grey		Grey	Grey	**4**	
Grey		Grey		Grey	Grey	**4**	
Grey	Grey	Grey		Grey		**4**	Blue
Grey		Grey	Grey			**3**	Blue
Grey				Grey	Grey	**3**	Blue
	Grey			Grey	Grey	**3**	
Grey		Grey		Grey		**3**	
Grey		Grey			Grey	**3**	
Grey		Grey			Grey	**3**	
Grey		Grey		Grey		**3**	
Grey		Grey		Grey		**3**	Blue
Grey		Grey		Grey		**3**	
Grey		Grey		Grey		**3**	
Grey		Grey			Grey	**3**	
Grey					Grey	**2**	
Grey					Grey	**2**	
Grey					Grey	**2**	
		Grey			Grey	**2**	
Grey		Grey				**2**	
	Grey			Grey		**2**	
Grey					Grey	**2**	
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Grey					Grey	**2**	
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						0	
						0	

An analysis of secondary task interaction per driver shows that most drivers engaged in several different types of secondary task, although rarely at the same time (Table 5). In the 765 coded trip sample, only six drivers were observed to perform multiple tasks at the same time. Within the sample, five drivers engaged in only mobile phone use, and performed no other type of secondary task. Six drivers engaged in only singing or talking and did not physically perform any distraction task. Four drivers performed no secondary task of any kind across 15 coded trips (mean trip duration = 22 minutes).

3.1.2 Mobile phone use

There was evidence of considerable variation in mobile phone interaction between drivers in the sample. Most drivers were observed to use their phone, but there was a wide range in frequency of use. Almost a third of drivers did not use their phone at all whilst driving.

Figure 3 shows the proportion of trips in which the whole driver sample used their mobile phone. Mobile phone use was prevalent in the UK sample of drivers with 35 drivers (69%) engaging in phone use in at least one trip. Sixteen drivers (31%) did not engage in any sort of phone use under any conditions. Four drivers used their phone in some way in all the 15 trips that were coded for them.

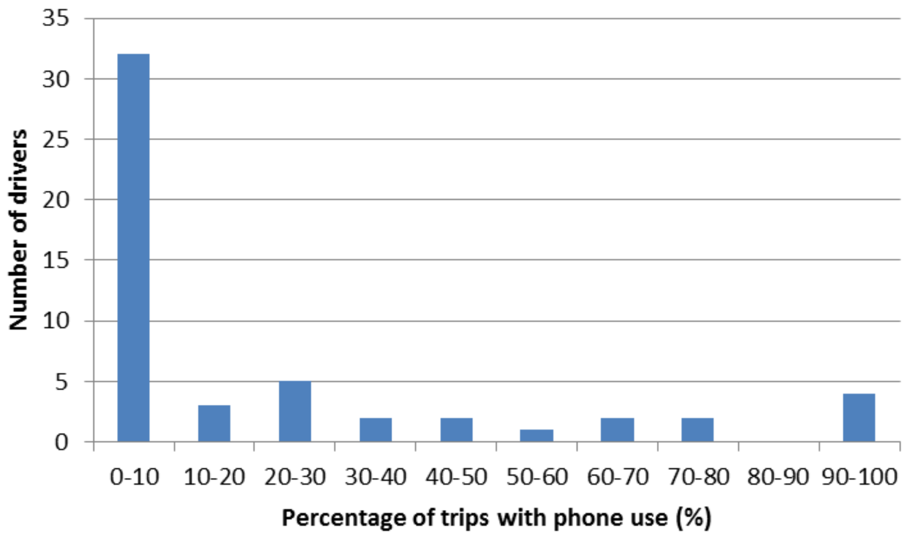


Figure 3: Frequency of phone use within the UK driver sample

Across the 765 trips coded, 662 distinct mobile interactions were observed in 111 trips. The majority of trips involved no mobile phone interaction, and when phones were used, this tended to be limited to a small number of interactions per trip (Table 6); 52% of trips involving phone use involved either one or two phone interactions; with only 5% of trips involving over 10 interactions. The highest number of phone interactions by a driver in a single trip was 16.

Table 6: Most trips involve low levels of mobile phone interaction. This table shows the proportion of trips featuring a given number of mobile phone interactions.

Number of phone interactions	Percentage of trips involving # of
0	85
1	4
2	3
3-10	8
>10	<0.1

The duration of a single phone interaction varied from less than one second to in excess of 40 minutes. Most distractions due to phones were a prolonged activity with only 40% of all phone interactions lasting less than 2 minutes (28% of interactions lasted less than 30 seconds and 12% of interactions lasted less than 10 seconds).

3.2 Mobile phone sub-task prevalence

This section presents a summary of the number of each mobile phone sub-task observed in the UK sample of 765 annotated trips. Specific details of each task type can be found in the annotation scheme in Appendix C.

Illegal handheld mobile phone use has been defined for this project using Regulation 110 of the Construction and Use Regulations 1986, as amended in 2003. In line with these regulations, handheld phone use is defined as the use of:

- A mobile telephone or other device with an **"interactive communication function".**
- A mobile telephone or other device that is **"held at some point during the course of making or receiving a call or performing any other interactive communication function".**

More detail can be found in Appendix E.

Figure 4 shows the mean duration for each sub-task in the UK driver sample.

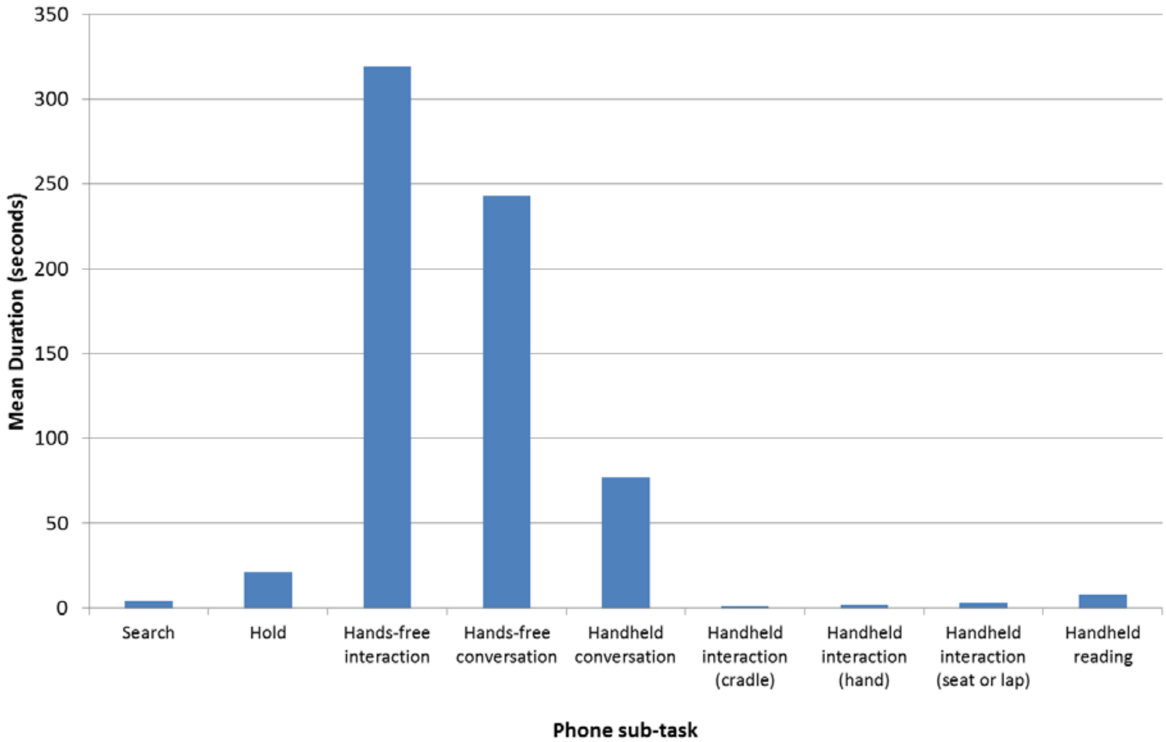


Figure 4: Mean duration of mobile phone sub-tasks in the UK sample (662 sub-tasks included).

Table 7 shows the breakdown of the mobile phone tasks observed in the UK driver sample.

Handheld interaction has been sub-categorised into illegal usage (phone in hand) and usage not covered by the handheld mobile phone regulations. (Note: handheld phone use outside of the regulations is not considered 'legal' use, and indeed usage of this kind e.g. on the lap or on the passenger seat is likely to be deemed unlawful in terms of wider road traffic offences such as not having proper control of the vehicle).

Table 7: Mobile phone sub-task interactions in the UK driver sample. This table shows for each sub-task the number of cases observed, the percentage of drivers observed, and the percentage of trips where it occurred.

Sub-task	Number of cases observed	Percentage of drivers performing sub-task (%)	Percentage of trips with sub-task (%)
Search	166	53 (27 out of 51)	12
Hold	138	47 (24 out of 51)	9
Hands-free interaction	28	22 (11 out of 51)	4
Hands-free conversation	10	10 (5 out of 51)	1
Handheld conversation	11	16 (8 out of 51)	1
Handheld interaction (hand)	188	49 (25 out of 51)	8
Handheld interaction (cradle)	76	6 (3 out of 51)	2
Handheld interaction (seat or lap)	7	6 (3 out of 51)	<1
Handheld reading	33	25 (13 out of 51)	3

Note: Search actions include glancing to find the phone or reaching towards the phone. A search interaction which is followed by another interaction e.g. a handheld call is coded as two sub-tasks: search then handheld conversation. Hold involves physical holding the phone but without manipulating it in any way.

The highest proportion of drivers performed a phone search (53%). This is unsurprising, as this activity is likely to precede many other types of mobile phone sub-task. This activity lasted on average for 4 seconds (maximum duration of 17 seconds), and often involves the driver removing their eyes being from the road ahead. 83% of phone search lasted for less than 10 seconds.

Nearly half of drivers were observed to hold their phone without performing a specific task with it for a period when the car was in motion. On average, a driver would hold their phone for 20 seconds before either putting it down or interacting with it further, with 66% of cases involving holding the phone for less than 10 seconds. However, there are many instances of prolonged holding of the phone (maximum duration of 5 mins 46 seconds) suggesting that in some cases drivers are choosing to keep hold of the phone ready for a future interaction.

Hands-free and handheld phone conversation were both observed rarely in the sample of coded trips, with only 10 cases of hands-free conversation (across 9 trips) and 11 cases of handheld conversation (across 11 trips). More drivers performed a handheld call (8) than a hands-free call (5). (However, the coded video streams do not include sound, and therefore there may be some instances of hands-free phone use that have not been captured). The similar frequency of both handheld calls and hands-free calls suggests that the laws regarding mobile phone use were either disregarded or misunderstood to some extent in our sample of drivers.

The mean duration for a hands-free conversation was considerably longer than for a handheld conversation (243 seconds vs. 77 seconds). Furthermore, only 3 of 11 handheld phone calls lasted for longer than 90 seconds. In contrast, only 2 of 9 hands-free calls were shorter than 90 seconds. The longest hands-free call lasted for over 13 minutes, compared to 4 minutes for a handheld call. This may suggest that drivers are aware that handheld phone use is illegal, and thus try to keep these types of calls brief, to minimise the chances of being observed or caught. However, caution should be applied before generalising this trend to a wider population, given that the UK driver sample size is small (n=51) and few calls were made or received, making it difficult to draw strong conclusions on behavioural trends. Future work should look to identify a larger sample of phone call cases to establish whether this trend is observed more widely.

3.3 Is there a blurred line between legal and illegal mobile phone use?

Handheld interaction – any physical interaction with the mobile phone screen or buttons – was frequently observed in the UK driver sample. This interaction was observed 271 times, involving 53% of drivers. 12% of trips involved a handheld interaction of some kind. These interactions tended to be short, with 19% lasting for less than 4 seconds (46% less than 10 seconds and 68% less than 20 seconds). The analysis sub-divided handheld interactions based on whether the phone was held in the hand during the interaction, placed on the lap or seat, or secured in a cradle.

For the following analysis, we report on only those interactions with the phone supported in the hand, that fall within the definition of handheld mobile phone use in the current regulations (Regulation 110, see Appendix E).

69% of handheld interactions involved drivers holding the phone. Nearly half of the sample of drivers used the phone in this way (25 out of 51). These prosecutable interactions were spread across 8% of trips, with an average duration of 2 seconds. Whilst brief, this task duration is potentially safety-critical if it involves the driver looking away from the road ahead and is performed with the vehicle in motion. This suggests that many drivers either misunderstand the existing laws relating to handheld phone use or perceive minimal impairment to their driving or risk of being caught from brief, short duration use. However, caution should be applied before generalising this trend to a wider population, given that the UK driver sample size is small (n=51). There is evidence of widespread handheld phone use, but we cannot be sure that these behavioural trends would be observed across the entire UK driving population.

Only three drivers used the phone in a cradle. Almost all of these instances were by a single driver. This driver also used the phone on the seat, so seemed reluctant to pick up and hold the phone at all. Handheld interaction with the phone resting on the seat or lap was also rare. Drivers tended to need to pick up their phone to complete the interaction that they intend to do, such as texting or scrolling.

An analysis of the number and duration of handheld interactions gives some insight into the understanding of the laws relating to handheld mobile phone use. There were 271 handheld interactions, which varied in length from less than a second to over 6 minutes of continuous interaction. Figure 5 shows the distribution of duration of handheld interactions in the UK driver sample. Of considerable concern is the finding that 20% of cases have a single interaction duration in excess of 25 seconds. Assuming this is accompanied by a driver's gaze being diverted from the road to the handheld device, this poses a considerable risk for safety.

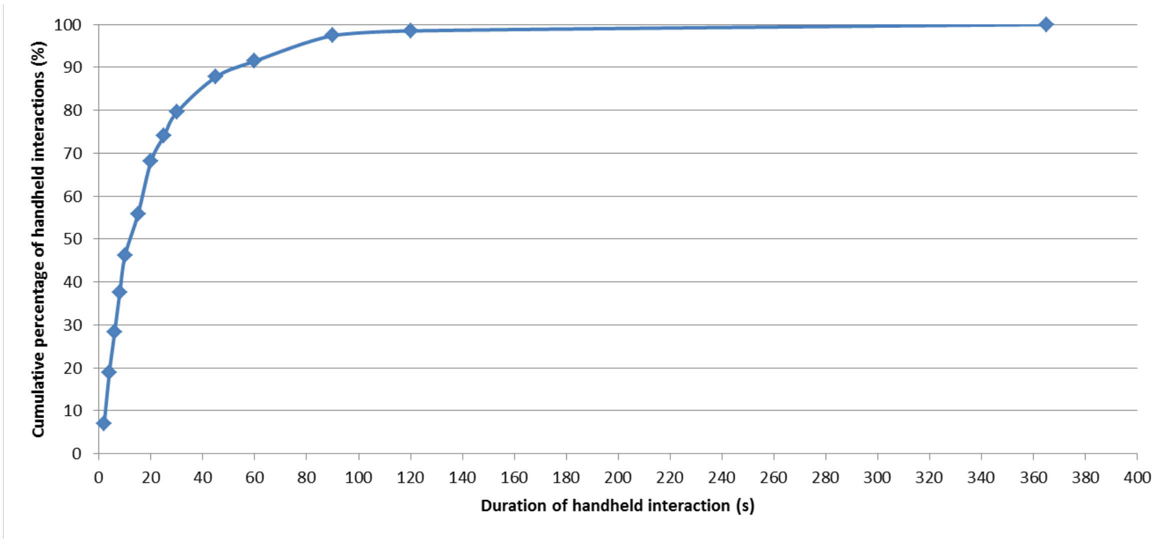


Figure 5: Duration of handheld phone interactions (excluding conversation; 271 cases, 27 drivers).

Overall, there were high levels of handheld phone usage in the UK driver sample. This was not just limited to phone calls, and instead, most handheld interactions were of a type that involves greater interaction with the screen than a typical call, such as composing a text message, checking a text message, or scrolling and searching actions associated with internet browsing. Furthermore, handheld interactions are often preceded by a phone search or a prolonged period of holding the phone. Where an interaction is 'handheld', most drivers are using their phone in a way that is prosecutable. There is some evidence here to suggest that the drivers in our sample did not fully understand the laws surrounding what constitutes handheld phone use, or they may have perceived little risk of enforcement for doing this. This latter point is corroborated by existing survey data, in which 28% of respondents agreed that "they will not be caught if they break most motoring laws" (RAC, 2018).

3.4 What is the influence of environmental conditions on mobile phone use?

We coded the environmental conditions at the onset of a mobile phone sub-task. This provided a single categorical variable for each instance of phone use for weather, road surface condition, time of day, road type and lighting condition.

Wet weather

30 mobile phone interactions (5% of all mobile phone interactions) occurred during rain, with only 1 conversation observed (handheld). Across the full 765 trip sample, 127 trips occurred in wet weather (17%), meaning that phone usage was less likely in the sample in wet conditions compared to dry conditions (Table 8). However, note that this analysis uses spot sampling of weather condition at the onset of a phone interaction, meaning that there may be small inconsistencies in the recorded weather conditions for long phone interactions.

Table 8: Phone sub-tasks in wet weather. This table shows the relative proportions of trips that occurred in dry and wet weather that featured each type of mobile phone sub-task.

Phone sub-task	Proportion of dry trips with activity (%)	Proportion of wet trips with activity (%)
Search	14	5
Hold	11	5
Handheld interaction (all)	10	2
Handheld conversation	<2	<1
Hands-free conversation	<2	0

The breakdown by sub-task shows that there were 8 cases of phone searching in the rain, 9 cases of holding the phone, 10 cases of handheld interaction, 1 handheld conversation, and 2 cases of handheld reading. There was little difference in the mean duration of a handheld call in wet and dry conditions (95 seconds vs. 75 seconds). Drivers tended to hold their phone for a shorter amount of time in the wet (7 seconds) than the dry (21 seconds). The average length of a handheld interaction also tended to be shorter in the rain (11 seconds) than in dry conditions (33 seconds). Overall, use of phones appears to be lower in wet weather.

Six drivers interacted with their mobile phone (hands free or hand held) in wet weather (12% of the UK sample). Two drivers were responsible for 20 of the 30 mobile phone interactions in wet weather. These two drivers were responsible for the only handheld conversation in wet weather, and 8 out of 11 (73%) of handheld interactions in wet weather. Further investigation is required, particularly across a larger sample of drivers, but there is tentative evidence from our sample to suggest that in most cases, drivers choose not to use their phone in wet weather.

There was no evidence in this sample that the onset of wet weather caused drivers to terminate phone use. No interactions were recorded in which phone use was halted within 20 seconds of rain appearing on the windscreen. This allows us to tentatively suggest that wet weather causes drivers to consider whether to start a task but does not necessarily lead to its immediate cessation.

A similar picture is observed for interactions when the road surface is wet; 54 interactions (8% of all mobile phone interactions) occurred with a wet road surface; including 2 handheld calls and 0 hands-free calls. Again, these interactions were confined to a small proportion of the driver sample (14%).

Case study: Female driver, late 20s, driving in winter in rainy weather in the morning

She is already holding her phone in her right hand and texting when the recording begins. She is driving on a 30 mph road and texting with many off-road glances to the phone. She continues to text while driving through a traffic light. On the approach to a roundabout, she puts the phone down between her thighs. She continues to drive for a while with no phone interaction. Then she picks up the phone with her right hand and starts texting again, holding the phone quite low. For one short moment, while still moving she has both hands off the wheel. Shortly after, she is texting with both hands while stopping at a traffic light on the entry to a signalised roundabout, but with the vehicle still moving. She glances up occasionally to check the light. Shortly before the light goes green, she places the phone down between her thighs. Once through the roundabout, she picks up the phone again with her right hand. She checks the phone and then puts it down again. She drives through another roundabout, and then picks up the phone again with her right hand and starts texting again while car following. There is a series of long glances down at the phone. She puts the phone back down and turns onto a narrower side street. Then she picks up the phone again and comes to a stop. She makes a call and a passenger gets in. She texts once more. Then she sets off with the phone between her thighs. She stops once more, and another passenger gets in. She puts the phone away. For the rest of the trip, there is not more phone interaction, just chatting with the passengers.

Points to be noted:

- The driver keeping the phone down between her thighs when she wants it available for use.
- The suspension of texting while negotiating the roundabouts, but not while car following.
- We presume that the strategy of keeping the phone in a low position, is to avoid detection of the usage from outside — this strategy increases the vertical and horizontal gaze angle, and thus leads to reduced ability to shift gaze to observe the road scene.

Road type

Urban roads were the most common location for mobile phone use in the sample, with 69% of interactions occurring on this road type compared to 18% on rural roads and 13% on motorways. Statistics taken from a Department for Transport report on Road Traffic Estimates (DfT, 2017) show the relative split of motorway, urban and rural driving time to be 20% motorway, 36% urban, and 44% rural. Extrapolating these road type figures to this sample it suggests; there is a 4.7 times greater likelihood of a driver using their phone in urban areas relative to rural areas, a 1.9 times greater likelihood of a driver using their phone in urban areas compared to on the motorway, and a 1.6 times greater likelihood of a driver using their phone on the motorway relative to rural areas. It should however be noted that the DfT national estimates may not accurately represent the split of driving per road type in the UDRIVE sample.

When broken down by sub-task, we see a similar pattern: urban roads were the most common location for all types of phone use (Table 9). There is a slight difference in the pattern of hands-free and handheld phone conversations. Both types of call were most common on urban roads. There was no observation of hands-free calling on rural roads, whereas handheld conversation was not seen on the motorway. However, it should be noted that these can only be considered trends for further research, given the low frequency of mobile phone calls overall within the sample. Further investigation would be required to determine whether the context (driving workload) or perceived threat of enforcement is modulating these behaviours in any way.

Table 9: Mobile phone sub-task interactions per road type. This table compares the number of observations of each mobile phone sub-task per road type. Road type is designated as urban, rural or motorway based on OpenStreetMap data. There is no identification of the Strategic Road Network (SRN).

	Search	Hold	Hands-free interaction	Hands-free conversation	Handheld conversation	Handheld interaction	Handheld reading
Urban	111	92	43	8	9	194	3
Rural	34	30	9	0	2	45	0
Motorway	21	16	9	2	0	32	2

Lighting condition

Most mobile phone interactions in the research occurred during daylight hours (80%). This trend was relatively consistent across all mobile phone sub-tasks (Table 10), suggesting that drivers were less willing to engage in this distracting behaviour during darkness. However, it is important to consider exposure to daylight and darkness conditions in this analysis. In the UDRIVE sample, 70% of trips occurred in daylight conditions (41628 out of 60140 trips), and so accounting for exposure, drivers are 1.7 times more likely to use their phone in daylight than in darkness.

Table 10: Mobile phone sub-task interactions per lighting condition. This table compares the number of observations of each mobile phone sub-task per lighting condition. Note that for this analysis, dusk and dawn are categorised as daylight conditions.

	Search	Hold	Hands-free interaction	Hands-free conversation	Handheld conversation	Handheld interaction	Handheld reading
Daylight	132	115	47	6	9	218	3
Darkness	34	23	14	4	2	53	2

Interestingly, 115 out of 132 cases of mobile phone use during darkness occurred when there was a nearby light source such as a street light, only 17 cases occurred in complete darkness (mostly rural roads or motorways with street-lighting switched off). The biggest difference in usage pattern between darkness (with additional lights) and complete darkness was seen in the visual-manual interaction categories. Only 2 out of 51 (4%) handheld interactions in darkness occurred when there is no surrounding light source. It may be that drivers feel less confident in their ability to remove their eyes from the road and retain control of the vehicle during complete darkness. There was no difference in levels of handheld and hands-free calls between darkness (with additional lights) and complete darkness, however, the sample size is small, so caution should be taken before generalising this finding.

Drivers in the sample rarely used their phone in the presence of passengers. Only 53 phone interactions (8%) occurred with a passenger present in the vehicle, despite a passenger being presented in nearly one-third of trips (32%). This can be expressed as an odds ratio, whereby drivers were **over 5 times more likely** to use their phone when travelling alone relative to travelling in the presence of a passenger.

Phone sub-tasks undertaken in the presence of passengers included only one handheld call and no hands-free calls. There were no instances where drivers initiated a call with a passenger present. Drivers rarely searched for their phone when a passenger was present - only 9 search cases (6%) occurred with another person in the vehicle. This may be because drivers feel some social pressure not to use their phone, or the passenger could be assisting them in locating it. Almost all (93%) handheld interactions occurred when a driver was not carrying a passenger and drivers who engaged in a handheld interaction did so for less time on average when a passenger was present (24 seconds) compared to when they were in the vehicle alone (33 seconds). There appeared to be some feeling within the UK driver sample that mobile phone use was not appropriate in the presence of passengers, hence we saw very little interaction when there were other individuals in the vehicle who could observe this behaviour. However, it could be that mobile phone use provides the driver with a degree of entertainment. This may be less important to the driver in cases where they are able to interact with a passenger. Additionally, in the presence of a passenger, drivers may simply have insufficient spare capacity to take on a further distracting phone task, or they may make use of the passenger to handle certain phone tasks for them e.g. texting or calling.

Female driver, early 30s, driving in winter at dusk with two phones in the vehicle

The trip starts in a town centre. The vehicle is not moving. She has a small phone in her right hand near to her lap. Her head is facing down. She moves the phone to the passenger seat alongside a larger iPhone. She glances toward the phone and touches one. She moves off on a 30 mph main road. She stops at a traffic light and touches one of the phones. After the light, she is moving slowly in traffic. She picks up the smaller phone, then checks the screen and puts it down again. She checks the iPhone and replaces it on the seat. She picks up the smaller phone, swipes it with her face looking down and then puts it back down on the seat. She enters a dual carriageway, picks up the small phone and then puts it down again. She enters a motorway, drives on it for a while and then exits. She stops at a traffic light, picks up the small phone and puts it back down. Driving on a dual carriageway, she glances at both phones. She picks up the iPhone and places it in a cradle to the left of the steering wheel. She dials a call and places the iPhone on speaker. She talks while driving in a tunnel. She stops in traffic with the iPhone still in speaker mode. She picks up the smaller phone from the seat and holds it low with both hands. The traffic in front move off and she notices that. She types a bit on the small phone and then replaces it on the passenger seat. The iPhone is still active. She picks up the small phone once again from the seat and swipes it with her left hand, while still talking via the iPhone. She replaces the small phone. Talks more, and glances at the small phone. Talks and glances at the small phone again. She picks up the small phone once more, swipes on it and gives it a long glance. She drops the small phone on the floor, looks down for a period and reaches down to pick it up, all while moving slowly in traffic. There are long glances to the small phone, and then a swipe. She puts the small phone on the passenger seat, and ends the call on the iPhone. Total call time is around 6 minutes.

She touches the iPhone and returns it to the home screen. She swipes on it and makes a long glance to the small phone. The small phone lights up. The iPhone dims and the screen goes dark. She enters a tunnel (40 mph urban motorway). She exits up a ramp to a roundabout and stops at the entry traffic light. She turns her head down, picks up the small phone, looks at it and then puts it back down on the passenger seat. She moves off, touches the iPhone and knocks it out of the cradle. She is able to catch it while moving slowly. She replaces it in the cradle and it goes dark. She grabs it from the cradle as she slows to a stop. She interacts in it with both hands and then places it on the passenger seat. She stops in traffic and picks up the small phone. She moves off while interacting on the phone with her left hand.

Points to be noted:

- The initial placing of both phones on the passenger seat.
- The usage of the iPhone: dialling by hand, but having a hands-free conversation (phone on speaker).
- The simultaneous use of two phones: was she perhaps checking her calendar on the second phone while talking on the iPhone?
- The very substantial physical and visual distraction from dropping the small phone and the near-disaster with the iPhone.

3.5 Where do drivers keep their mobile phones?

Understanding 'safe' and 'unsafe' locations for phones (i.e. not likely to be picked up by individuals) can help develop driver education and targeted media campaigns. The analysis revealed that the most frequent location of the phone when drivers start to use it was a cradle (26%), followed by passenger seat (22%), centre area near the gearstick (19%) and on driver's seat or lap (18%). Driver's pocket location accounted for the lowest frequency (1%) (Figure 6). In most cases where a phone was located on the driver's lap, a seat or in a cradle before the interaction, it was picked up in the hand to use, meaning that the interaction then broke the law. Drivers rarely removed a phone from their pocket to use it; perhaps suggesting that visibility not proximity is a key factor in determining whether an individual uses their phone whilst driving.

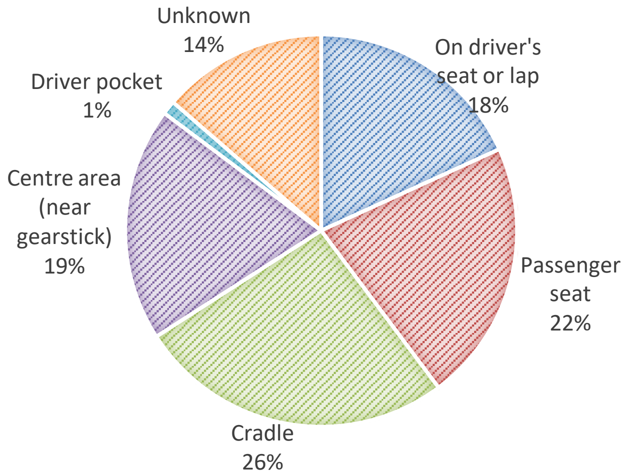


Figure 6: Mobile phone location at the time of task initiation. Unknown locations are those out of view of the cameras, where starting location could not be coded with 100% certainty.

Case study: Female driver, early 30s, driving in spring in mid-afternoon

At the start of the trip recording, she is driving on a 30 mph road, holding a phone in her right hand and swiping. She stops at a traffic light and makes long glances down and to the right. She starts typing with both hands. She places the phone on the passenger seat and moves off. While moving, she picks up the phone. She briefly holds it with both hands, and then moves it to her right hand. She glances at the phone several times and then dials. With her right hand, she places the phone between her neck and her left shoulder. She is having a phone conversation. She steadies the phone with her right hand. She stops at a traffic light and holds the phone with both hands. She puts the phone down on the passenger seat. She is still at the red light.

Points to be noted:

- Use of the passenger seat as resting place for the phone.
- Having both hands on the phone on more than one occasion, which at one time results in driving with no hands on the wheel.
- Holding the phone between neck and shoulder.

3.6 In what circumstances do individuals initiate mobile phone use?

Drivers in our sample often performed an illegal action (handheld use) before performing a legal action. An observation of all handheld and hands-free calls showed that drivers start calls manually in almost all cases. In the case of handheld conversation, every call involved a manual interaction with the phone, either to place the call or to answer it. For hands-free interaction, 20% of calls were answered by pressing a button on the in-vehicle interface. However, all other interactions to answer or place a call involved contact with the phone itself whilst it was placed in the hand. This suggests that the drivers observed in the sample did not appreciate that these interactions are deemed illegal under the current regulations on handheld mobile phone use, in addition to a fully handheld conversation.

3.7 Does mobile phone usage have detrimental effect on driving performance?

We analysed speed choice and following distance to the vehicle in front during mobile phone use amongst sampled drivers. This data was gathered from the vehicle controller area network (CAN) and was recorded at 10Hz (10 times per second).

Table 11 shows some key metrics related to speed and distance to the vehicle in front during phone use. Time-to-collision refers to the time it would take the driver's vehicle and the vehicle in front to collide if they were both to maintain their current speed and direction. In some cases, where the lead vehicle is moving faster than the follower, the two vehicles would never collide.

Table 11: Driver behaviour during phone use. This table shows how following distance to the leader vehicle (expressed as time-to-collision) varies with different mobile phone sub-tasks.

Sub-task	Percentage of cases when stationary (%)	Percentage of cases with a vehicle in front (%)	Minimum TTC observed (seconds)	Mean TTC observed (seconds)
Search	12	18	2.0	20
Handheld conversation	0	18	2.1	30
Hands-free conversation	0	12	1.7	3
Hold	9	16	1.4	32
Handheld interaction	11	22	1.3	22
Handheld reading	13	25	2.3	26
Hands-free interaction	5	20	1.2	4

Importantly, for all categories of mobile phone sub-task there were cases where the driver's time-to-collision (TTC) drops below 2.5s. This means that without evasive action (i.e. maintaining their current speed and heading), the two vehicles would collide in under 3 seconds. This shows that drivers in the sample are not limiting their mobile phone use to non-safety critical situations.

All phone conversations took place whilst the vehicle was in motion, with a considerable proportion of these conversations taking place when following another vehicle. There is a difference in the mean TTC when engaging in a handheld conversation compared to a hands-free conversation. On average, drivers spent more time at shorter, more safety-critical TTC when engaging in hands-free conversation. In contrast, drivers were 30 seconds away on average from colliding with the lead vehicle when holding a phone and making a call. This suggests that drivers are making larger adjustments in the following behaviour when making handheld calls. However, it should be noted that this is based on a sample of only 21 phone conversations observed.

Handheld interaction took place when stationary in 11% of cases. Nearly a quarter of interactions occurred when following a lead vehicle; a cause for concern given that the interaction likely involved the driver directing their eyes away from the road ahead. Eight per cent of handheld interactions occurred with a mean speed of 30 mph or higher (2% at 50 mph or higher).

There were observations of handheld conversation and handheld interaction occurring at speeds more than 70mph. If combined with close following and looking away from the roadway, these types of interactions have the potential to lead to severe safety consequences.

3.8 Spotlight on mobile phone use at intersections

This section looks at the prevalence of mobile phone use whilst performing manoeuvres at intersections and investigates how drivers manage such activities in accordance with changing road layout and driving demand at these locations. Specifically, the investigation sought to ascertain whether mobile phone interaction at intersections is influenced by driver-related factors, such as age and gender, and environmental variables including passenger presence, weather condition, intersection layout, and vehicle motion (moving or stationary). The investigation also looked at mobile phone usage at different stages of the intersection; the approach stage (upstream functional area), the during stage (intersection physical area) and the exiting stage (downstream functional area).

Case Study: Male driver, mid-30s, driving on motorway in winter in daylight

He has a phone between his legs on his seat. He receives a call, picks up the phone with his left hand, passes it to his right hand and holds it to his ear. He is driving at 56 mph. He takes his left hand off the steering wheel and gestures while moving at 50 mph. He exits the motorway, drives through a roundabout and continues on a 60 mph rural road. The phone call ends after 1 min 40 secs, and he returns the phone to its original position.

Points to be noted:

- The initial and final positions of the phone — resting on the driver's seat, between his legs.
- The gesturing, which indicates substantial emotional involvement in the content of the call.
- The persistence of the phone call across road categories and manoeuvring through the roundabout.

What was the prevalence of mobile phone usage at intersections?

Six per cent of intersections involved phone use (101 intersections of the 1630 coded), with 132 distinct interactions observed. In the UK, 10 drivers performed at least one mobile phone activity at an intersection. The most frequently observed activity was hands-free interaction, followed by handheld interaction and hands-free conversation (Table 12). Handheld conversation activity was very rarely observed at intersections. This contrasts with the full trip statistics; where we saw handheld conversation and hands-free conversation occurred with similar frequency – however, note the low frequency of phone calls throughout both datasets. The increased demand of driving through an intersection appeared to reduce drivers' willingness to perform a handheld call.

Table 12: Frequency of mobile phone sub-tasks at intersections. The relative frequency of different phone tasks can be compared.

Mobile phone subtask	N	Relative frequency (%)
Hands-free conversation	29	22.0
Hands-free Interaction	44	33.3
Handheld conversation	6	4.5
Handheld interaction	32	24.2
Holding	12	9.1
Related	9	6.8
Total	132	100.0

Note: 'Related' means that the driver is interacting with a phone in some manner not covered by another category, such as plugging phone into a charger, cleaning the screen, putting on headset.

The proportion of intersection driving time where drivers engaged in each mobile phone sub-task was also considered (Figure 7). Drivers spent the most time engaging in hands-free interactions, although still a low proportion of the total driving time. Handheld conversation occupied the lowest proportion of intersection driving time.

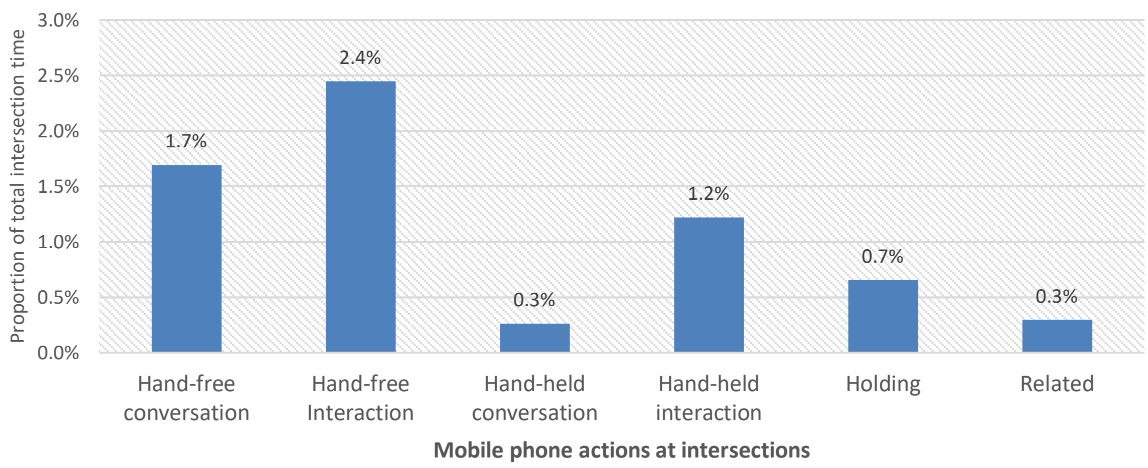
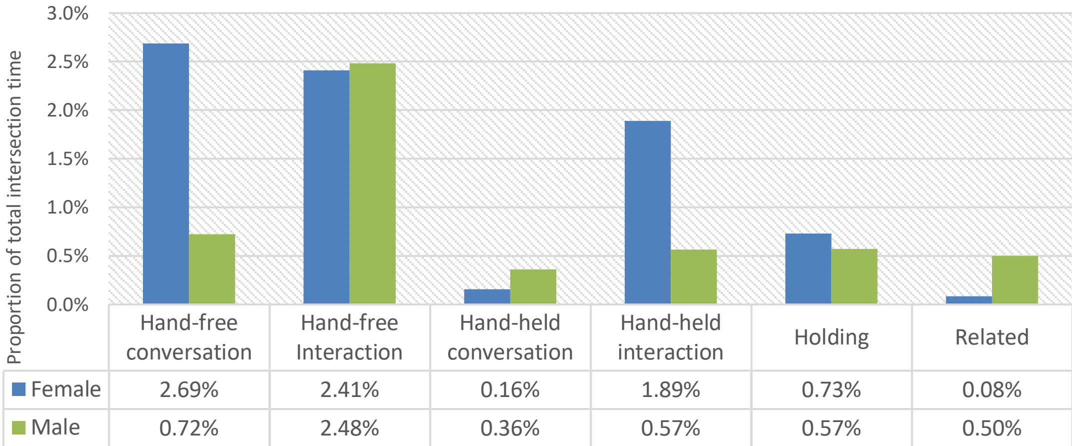


Figure 7: Proportions out of total intersection time by mobile phone sub-task

To what extent was the willingness to engage in mobile phone activities at intersections dependent on age and gender?

Female drivers in the sample spent a higher proportion of their travel time at intersections engaged in mobile phone activities (8%) compared to male drivers (5%). When analysed by sub-task, there are some suggestions of gender differences in behaviour (Figure 8). Males have slightly higher rates of handheld conversation than females, whilst females spend a higher proportion of their travel time engaging in hands-free conversation and handheld interaction. It should however be noted that females were observed to carry passengers less often than males in the UK sample of drivers; hence differences in behaviour may not be attributable to gender alone. This analysis is also performed on a sample of only 51 drivers, with randomly selected trips, hence cannot be considered representative of the wider UK driving population. Broadly speaking, mobile phone usage at intersections decreased with increasing age, with drivers over 40 years old engaging in phone use considerably less than drivers under 40 years old.

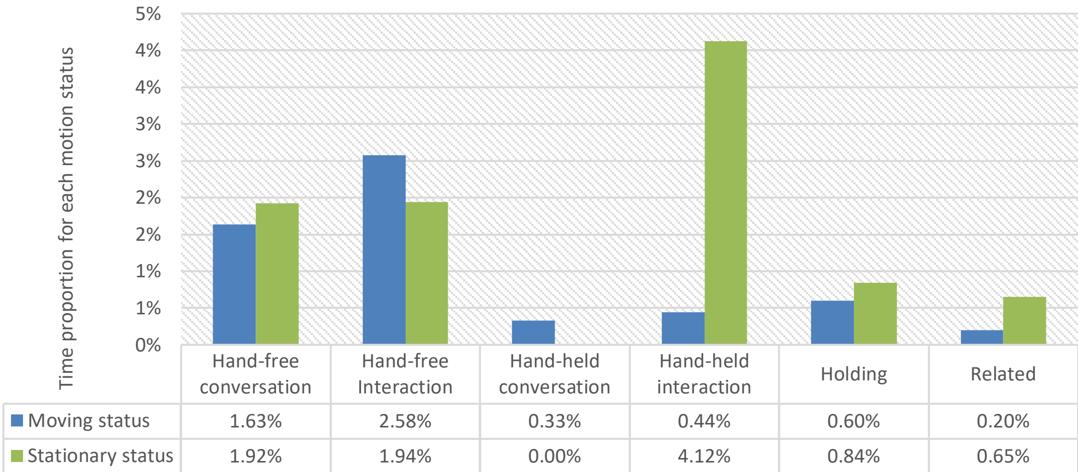


	Hand-free conversation	Hand-free Interaction	Hand-held conversation	Hand-held interaction	Holding	Related
Female	2.69%	2.41%	0.16%	1.89%	0.73%	0.08%
Male	0.72%	2.48%	0.36%	0.57%	0.57%	0.50%

Figure 8: Proportion of interaction time during intersections by mobile phone sub-task and gender

Did drivers adjust their mobile phone activities across motion statuses?

Drivers considerably increased the proportion of time devoted to mobile phone activities when their vehicles were stationary (10% of intersection travel time on average) compared with when their vehicles were moving (6%). This trend was applicable for most mobile phone sub-tasks (Figure 9).



	Hand-free conversation	Hand-free Interaction	Hand-held conversation	Hand-held interaction	Holding	Related
Moving status	1.63%	2.58%	0.33%	0.44%	0.60%	0.20%
Stationary status	1.92%	1.94%	0.00%	4.12%	0.84%	0.65%

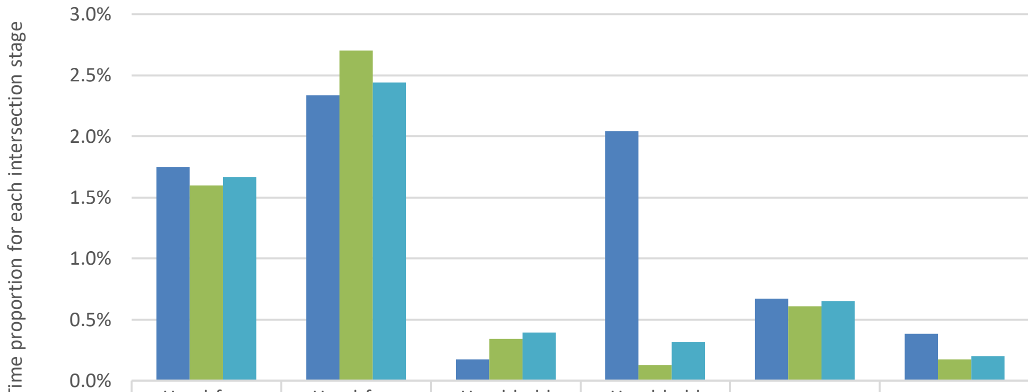
Figure 9: Proportion of time for each mobile phone sub-task when moving and when stationary.

The only exception for that is the hands-free interaction activity in which drivers spent a lower proportion of time performing this task when stationary. A noteworthy result is that drivers showed an increase in the amount of time devoted to handheld interaction activities when they were stationary compared to when they were moving. It appears that the drivers in our sample made a judgement about when it was safe to engage in handheld phone use and either disregarded the law in these cases, or simply may not have been aware of the intricacies of the law and how it applied in moving and non-moving cases. However, whilst the vehicle is not in motion, these tasks could still have a potential impact on road safety, either through distraction and reduced situation awareness when the driver moved off from stationary or a carryover effect (either cognitive or physical) which impairs driving performance.

Did drivers adjust their mobile phone activities across intersection stages?

Drivers use their mobile phones more on the approach to intersections (7.4%) than during (5.6%) or immediately after driving through them (5.7%). Drivers appeared to abandon mobile phone activities for the time that they are driving through the intersection itself. This could be due to the higher workload associated with driving through a junction or roundabout, due to a more challenging road layout and the greater potential for conflicts with other road users.

When broken down per sub-task, we saw little difference in performance across the three intersection stages, except for handheld interaction. Figure 10 illustrates that handheld interaction was most common on the approach to intersections and drops off sharply in the during and after stages. This could be explained by a combination of the driving demand on the approach to an intersection and the greater likelihood of the vehicle being stationary on the lead in to an intersection. Indeed, on the approach to an intersection, phone use whilst stationary is over four times more likely that phone use whilst in motion. Drivers in the sample readily picked up their phone to use it handheld when they were forced to stop on the approach to an intersection. These stopping instances were due to a combination of both traffic lights and congestion ahead.



	Hand-free conversation	Hand-free Interaction	Hand-held conversation	Hand-held interaction	Holding	Related
Upstream stage	1.75%	2.34%	0.18%	2.04%	0.67%	0.38%
During stage	1.60%	2.70%	0.34%	0.13%	0.61%	0.18%
Downstream stage	1.66%	2.44%	0.39%	0.32%	0.65%	0.20%

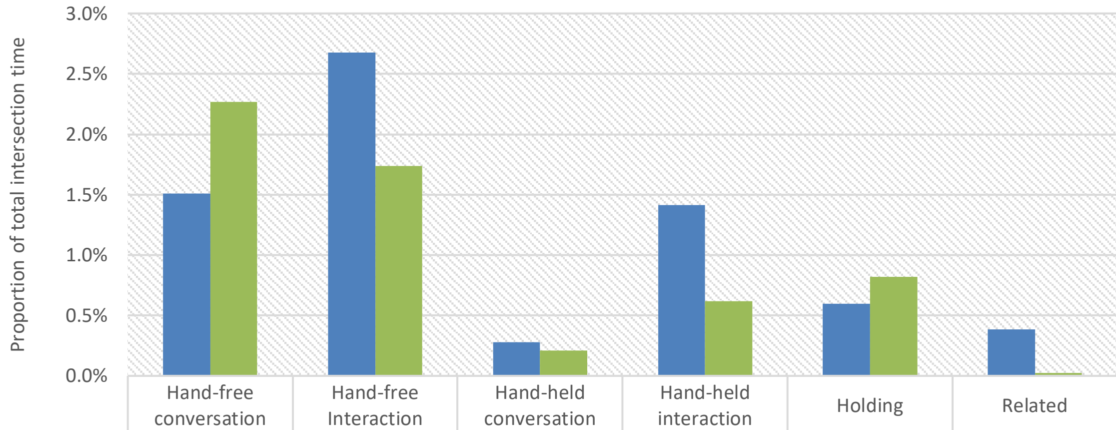
Figure 10: Proportion of time for each mobile phone sub-task across intersection stages

Mobile phone use at intersections and other environmental variables

Overall, drivers in our sample were less likely to perform mobile phone activities when passengers were present, as was the case with the full-trip dataset. However, we cannot tell from this evidence whether the mere presence of passengers is the cause of this effect or whether they provide replacement activities, such as talking, for the driver to engage in. This could be investigated by conducting a naturalistic driving study that collected audio data from inside of the vehicle, so as to reliably identify conversation with passengers, especially those not in full view of one of the in-vehicle cameras. There would be ethical issues with recording conversation, so any audio data would need to be scrambled or anonymised.

Drivers spent a lower proportion of their intersection travel time engaged in mobile phone activities during bad weather (including adverse conditions such as rain, snow, fog). This result holds over all the mobile phone sub-tasks and is especially pronounced for the handheld interaction category. Again, many drivers seemed to be aware of the increased demand of driving in adverse conditions, and thus did not engage in mobile phone tasks as readily. However, phone use did not disappear entirely in these conditions.

Drivers spent a slightly lower proportion engaged in mobile phone activities at roundabouts compared to non-roundabout intersections (Figure 11). The breakdown of phone interactions by sub-task provides some evidence that drivers were more likely to perform hands-free interactions, handheld interaction, and handheld conversation activities at intersections, while they were more likely to perform hands-free conversation and holding activities at roundabouts.



	Hand-free conversation	Hand-free Interaction	Hand-held conversation	Hand-held interaction	Holding	Related
Intersection	1.51%	2.67%	0.28%	1.41%	0.60%	0.38%
Roundabout	2.27%	1.74%	0.21%	0.62%	0.82%	0.02%

Figure 11: Proportion of intersection time involving mobile phone sub-tasks per intersection type.

3.9 What is the influence of personality on mobile phone use?

3.9.1 Questionnaires

Drivers were presented with a suite of questionnaires before taking part in the UDRIVE project to measure a range of dimensions of their driving personality. These included the following self-report metrics:

- **Driver Attitude Questionnaire** (DAQ) (20 items assessing attitudes towards speeding and close following behaviours);
- **Driver Behaviour Questionnaire** (DBQ) (19 items assessing the prevalence of errors and violations in the driver's everyday behaviours);
- **Driver Skills Questionnaire** (DSQ) (15 items assessing how drivers behave in a series of described driving scenarios including speeding behaviour, travelling with passengers, engaging with distractions, journey planning etc.)
- **Traffic Locus of Control** (TLOC) Questionnaire (17 items assessing views towards the factors that cause road accidents, specifically themselves, others, the road and environment, or fate);
- **Arnett Inventory of Sensation Seeking** (AISS) (20 items assessing the risk-taking and sensation-seeking nature of a driver's personality).

The five questionnaires above have been subjected to factor analysis in prior work, which has been assumed validated for the purposes of this analysis (Warner et al., 2010; Department for Transport, 2005; Özkan & Lajunen, 2005; Lajunen et al., 2004; Parker et al., 1996; Arnett, 1994; French et al., 1993; West et al., 1993). The subscales derived from factor analysis have been used as independent variables to represent attributes of driver personality.

3.9.2 Cluster analysis

To determine to what extent drivers' personality factors might be associated with mobile phone use, we analysed the data using a market segmentation approach i.e. cluster analysis. Cluster analysis is a multivariate method, which aims to classify a sample of subjects (in this case, driver) based on a set of measured variables, into a few different groups such that similar subjects are placed in the same group (see Appendix B for more detail on the cluster analysis methodology).

The analysis grouped the UK drivers into three distinct clusters, distinguished based on their responses to the Traffic Locus of Control (TLOC) personality questionnaire. The mobile phone use of each cluster was then analysed. Whilst caution should be applied before extrapolating these clusters to the wider UK population (given the low sample size on which they are based), this analysis suggests that there are sub-categories within the driver sample relating to phone use.

Based on their TLOC questionnaire response, these groups were named the *mindful* (cluster 1), *blame-takers* (cluster 2) and *blamers* (cluster 3):

Cluster 1 'Mindful'

- Perceive themselves, other drivers, vehicle and environment factors, and fate to contribute similarly to causing road accidents. A relatively low tendency to blame crash involvement on the actions of others or on fate.
- Reports the lowest use of mobile phones and other devices (nomadic) taken into the vehicle.
- Reports that it is easy to avoid distractions.
- More inexperienced drivers, which may account for their greater risk of accident involvement.

Cluster 2 'Blame-takers'

- Highest rating for the Self factor in terms of accident causation; implying that these individuals perceive a significant personal responsibility for the causes of road accidents.
- Low ratings for the contribution of Fate to accident causation.
- High nomadic device usage and highest reported difficulty avoiding distractions when driving.
- High reported frequency of mobile phone usage.

Cluster 3 'Blamers'

- High ratings for the involvement of all non-Self factors in accident causation (Others, Vehicle and Environment, Fate) implying that these individuals do not perceive themselves to be responsible for the causes of accident, relative to other causes.
- Highest reported mobile phone usage and considerable difficulty avoiding distractions.

Table 13 shows the mean responses of each cluster on the subscales of the TLOC questionnaire, and Table 14 shows the demographic composition of the clusters and their self-reported risk of accident involvement. The sensation seeking (AISS) scores of the clusters seem to be closely related to handheld mobile phone use, indicating that general propensity to take risks is a predictor of usage.

Table 13: Personality characteristics of the clusters. This table shows the mean score on each sub-scale of the TLOC questionnaire for each driver cluster.

Factors	Cluster 1 (n=15)	Cluster 2 (n=19)	Cluster 3 (n=16)
TLOC-self	2.33	3.52	3.08
TLOC-other	3.47	4.26	4.43
TLOC-vehicle	2.78	3.58	3.92
TLOC-fate	2.53	1.58	3.02

Table 14: Demographic, driving and AISS profiles of the clusters. This table shows the mean value for various factors used to explain the profiles of the three driver clusters identified during cluster analysis.

Factors	Cluster 1 (n=15)	Cluster 2 (n=19)	Cluster 3 (n=16)
Mean age	43.23	48.96	41.74
Gender	8 males; 7 females	10 males; 9 females	7 males; 9 females
Driving experience in years	4 (0-3); 11 (>3)	0 (0-3); 19 (>3)	1 (0-3); 15 (>3)
Accident involvement	.79	.16	.25
AISS-overall	39.20	48.11	51.44

Table 15 shows the number of drivers engaging in each mobile phone task per cluster. Cluster 1 self-reports lower levels of mobile phone use and this trend is observed in the coded trip data.

Table 15: Number of mobile phone sub-task interactions by driver cluster. Note the higher number of mobile phone interactions in Clusters 2 and 3.

Sub-task type	Cluster 1 drivers n = 15	Cluster 2 drivers N = 19	Cluster 3 drivers n = 16
Handheld conversation	2	5	3
Handheld interaction	7	10	10
Handheld reading	3	3	7
Phone search	7	10	10
Phone hold	5	9	10
Hands-free conversation	2	1	2
Hands-free interaction	3	5	3
TOTAL	**29**	**43**	**45**

Of the 35 drivers in the sample who engaged in phone use of some type, almost all of them (27 drivers, 82%) performed multiple types of mobile phone task across the trips that were annotated. Only one driver who engaged in mobile phone use restricted their interactions to hands-free interactions. Annex D shows the mobile phone use across the entire UK sample, broken down per mobile phone sub-task. There were drivers in all clusters who did not engage in any form of mobile phone use. So, while personality variables offer some predictive value in whether a driver engages with distraction in the sample, several other factors also influence the occurrence of this behaviour.

4. Conclusions

Drivers in the UK sample used their mobile phones in a variety of ways and contexts. Most UK drivers in the UDRIVE sample used their mobile phone whilst driving on some occasion, though they could also have trips without mobile phone use. Over 50% of drivers were observed holding or interacting with the phone using one or more hand. Thus, many drivers in the sample did not comply with the law on handheld usage of a mobile phone. Some of that non-compliance may be unintentional, e.g. drivers may believe that handheld use not involving a conversation may be legal or that beginning a call in hand before enabling hands-free use was also legal. On the other hand, the propensity of drivers to keep their phones low down to avoid the phone use seen from outside the vehicle, observed in the case studies, indicates that some drivers at least are aware that what they are doing is illegal. Only one driver used their phone entirely hands-free.

Mobile phone conversation was quite rare in the sample, but it is evenly split between handheld and hands-free. Drivers appear to keep handheld conversations brief.

Most interactions with mobile phones in the sample occurred when stopped or at low speed, indicating that drivers in the sample were self-regulating their behaviour. Drivers used phones less during intersections than in baseline (non-intersections) driving, providing further evidence for a tendency to adapt to driving situation and driving task demand. Handheld phone use seemed to be abandoned while drivers negotiated intersections; on the other hand, hands-free phone use was generally observed to continue through an intersection. This could be in part related to the need to have both hands available for vehicle control (steering and gear-shifting) when manoeuvring.

In terms of safety, we are concerned about the impact of mobile phone use on drivers' maintenance of a safe gap to the lead vehicle. There is also some evidence from the case studies that drivers in our sample keeping their phones low to avoid detection. This was likely to have a detrimental effect on their observation of the road scene and detection of hazards. There were, in the case studies, some extreme by-products of mobile phone use in terms of periods of driving with no hands on the wheel and also risks of dropping an unsecured phone.

Most drivers in our sample kept their phone within arm's reach when driving, with popular positions being on the passenger seat or between the driver's legs on the driver's seat. From the case studies, having the phone close to hand often led to frequent checking of the phone, either by glances or by picking the phone up to view the screen. This indicates a connection between location and temptation to use.

The cluster analysis suggests that personality factors may predict mobile phone use to some extent. There is evidence to suggest that handheld mobile phone use is related to overall attitudes towards risk-taking, as well as to a tendency to blame crashes on the actions of others or on fate.

5. Discussion and future work

The findings suggest some themes for media campaigns. The finding that mobile phone interaction is less frequent in the company of passengers could be a potential route to sending a message to drivers about phone use. Campaigns could mention how the dangers of phone use do not disappear when a driver is travelling alone, and thus drivers should consider this before interacting with a phone. Perhaps they could be asked to decide whether they would make this call if there were a passenger in the vehicle. Also, keeping a mobile phone out of easy reach — in a handbag, pocket or the glove compartment may reduce the temptation to use it while driving. Drivers are not able to resist frequent checking when the phone is nearby, and they will also respond to being called and be tempted to make calls.

There is an indication that drivers may be confused about what is meant by “hands-free” phoning, as indicated by the frequency of handheld interactions with the phone (aside from calls) and the high likelihood that a hands-free call is initiated via a manual interaction with the phone. There may therefore be some unintentional violation of the restriction on hand-held phone use. On the other hand, some drivers are using the strategy of keeping their phones low down, in the hope that this will reduce the risk of detection. Thus, the current law may be creating an unintended consequence that is detrimental to safe driving. Low-down usage needs to be discouraged, perhaps through extending the use of “taller” vehicles for enforcement by the police (already applied for targeting handheld use by truck drivers) and using high-mounted cameras on gantries. There could also be room for re-phrasing the existing regulations to make it clearer what is considered handheld use. In terms of safety effects of in-vehicle phone use, there are strong arguments in the literature, that other types of phone interaction should be restricted in the driving environment.

Given the personality findings, the issue of responsibility could be a focus in campaigning. Drivers who attribute more responsibility for accidents to other drivers tended to use their phones more, especially handheld. There is also links between phone use and self-reported sensation-seeking or risk-taking propensity, meaning that risk-takers may also be a driver group to target with education or campaigns to reduce phone use during driving.

In terms of future work, the application of computer vision to code mobile use in the UDRIVE and other naturalistic driving databases would immensely increase the efficiency of the coding process and result in larger datasets of mobile phone use and hence more power in analysis. An additional research issue is also suggested by the findings. The UK participants in UDRIVE tended to suppress mobile phone usage when manoeuvring, perhaps to have both hands available for steering and gear-shifting. But all the car-driving participants in UDRIVE (in the UK and the other countries) were driving cars with manual transmission. Are drivers of vehicles with automatic transmission more willing to engage in handheld mobile phone usage? That question cannot be answered from UDRIVE, but the prevalence of automatic transmission in the U.S, vehicle fleet may have the side effect of making handheld mobile phone use easier and therefore may be a part explanation of the higher rate of such usage observed there.

Further work is also required into the links between driver personality and mobile phone usage. This dataset has provided hints of a relationship but more robust data collection across a larger sample of drivers would be required to demonstrate this conclusively. This would then allow marketing campaigns to potentially be targeted towards certain driver types. An extension of the dataset to different vehicle types would also allow mobile phone use across a more representative sample of the driving population to be investigated.

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Appendix A: UDRIVE participant questionnaires

The following suite of questionnaires was delivered to participants during an information event, held three months in advance of the UDRIVE data collection period.

Participants were advised that they should answer as accurately as possible, but they were free to ignore any questions that they did not wish to respond to. As per the consent process for the UDRIVE project, participants were assured of the anonymity of their data and that future use of the data for analysis purposes would not allow them to be identified as an individual.

However, it should be acknowledged that some participants may not have been completely honest in their responses or may not be able to accurately introspect on certain behaviours or thoughts. Therefore, self-report data should be viewed with some degree of caution.

All questionnaires have been validated in the transport field and are widely used metrics. The five questionnaires have been subjected to factor analysis in prior work, which has been assumed validated for the purposes of this analysis (Warner et al., 2010; Department for Transport, 2005; Özkan & Lajunen, 2005; Lajunen et al., 2004; Parker et al., 1996; Arnett, 1994; French et al., 1993; West et al., 1993). The subscales derived from factor analysis have been used as independent variables to represent attributes of driver personality. The scoring and analysis process for each questionnaire can be seen in more detail in the references listed below (full details in the References):

- **Driver Attitudes Questionnaire (DAQ):** Parker et al., 1996 - 20 items assessing attitudes towards speeding and close following behaviours);
- **Driver Behaviour Questionnaire (DBQ):** Lajunen et al., 2004 - 19 items assessing the prevalence of errors and violations in the driver’s everyday behaviours);
- **Driver Skills Questionnaire (DSQ):** French et al., 1993 - 15 items assessing how drivers behave in a series of described driving scenarios including speeding behaviour, travelling with passengers, engaging with distractions, journey planning etc.
- **Traffic Locus of Control (T-LOC):** Özkan & Lajunen, 2005. - 17 items assessing views towards the factors that cause road accidents, specifically themselves, others, the road and environment, or fate;
- **Arnett Inventory of Sensation Seeking (AISS):** Arnett, 1994. - 20 items assessing the risk-taking and sensation-seeking nature of a driver’s personality.

UDRIVE

European Naturalistic Driving Study

Participant questionnaires

Thank you for agreeing to participate in this research project, which will help us to more fully understand the interaction between the driver, the vehicle, and the road environment.

We invite you to complete a set of questionnaires which is part of the study. Please answer the questions intuitively and honestly. It is important to make you aware that we are not looking at your individual driving style or judging your ability as a driver. We are solely interested in the behaviour of a group of drivers to draw conclusions about drivers in general.

All information collected via the questionnaire will be dealt with in the strictest confidence and will only be used for research purposes.

Should clarification of any questions be required, please do not hesitate to ask a member of the research team.

Please turn over the page and start completing the questions.

Participant id: _______________

About your attitude towards traffic behaviour [Driver Attitude Questionnaire; DAQ]

To what extent do you agree with each of the following statements? Please tick an option for each statement.

I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree

1. People stopped by the police for close-following are unlucky because lots of people do it
2. Speed limits are often set too low, with the result that many drivers ignore them
3. Close following isn't really a serious problem at the moment
4. I know exactly how fast I can drive and still drive safely
5. I would favour stricter enforcement of the speed limit on 30 mph roads
6. Some people can drive safely even though they only leave a small gap behind the vehicle in front
7. Even driving slightly faster than the speed limit makes you less safe as a driver
8. I would be happier if close-following regulations were more strictly applied
9. Stricter enforcement of speed limits on 30 mph roads would be effective in reducing the occurrence of road accidents
10. Even driving slightly too close to the car in front makes you less safe as a driver
11. On the whole people aren't aware of the dangers involved in close following
12. I would be happier if the speed limits were more strictly enforced
13. Harsher penalties should be introduced for drivers who drive too close to the car in front
14. It's OK to drive faster than the speed limit as long as you drive carefully
15. People stopped by the police for speeding are unlucky because lots of people do it
16. I think the stopping distances in the Highway Code are too great for people to take notice of them
17. Speeding is one of the main causes of road accidents
18. It is quite acceptable to drive close to the car in front than is recommended
19. Sometimes you have to drive in excess of the speed limit in order to keep up with the flow of traffic
20. I would favour a clamp down on drivers who drive too close to the vehicle in front

About your usual driving habits [Driver Behaviour Questionnaire; DBQ]

For each driving situation described in the table below, please indicate how often each situation has applied to you in the last three months. Please place a tick on an option per line.

Never	Hardly ever	Occasionally	Quite often	Frequently	Nearly all

1. Queuing to turn left/turn right onto a main road, you pay such close attention to the main stream of traffic that you nearly hit the car in front of you
2. Fail to notice that pedestrians are crossing when turning into a side street from a main road
3. Sound your horn to indicate your annoyance to another road user
4. Fail to check your rear-view mirror before pulling out, changing lanes, etc.
5. Brake too quickly on a slippery road or steer the wrong way in a skid
6. Pull out of a junction so far that the driver with right of way has to stop and let you out
7. Disregard the speed limit on a residential road
8. On turning left nearly hit a cyclist who has come up on your inside
9. Miss “Give Way” signs and narrowly avoid colliding with traffic having right of way
10. Attempt to overtake someone that you had not noticed to be signaling a right turn
11. Become angered by another driver and give chase with the intention of giving him/her a piece of your mind
12. Stay in a motorway lane that you know will be closed ahead until the last minute before forcing your way into the other lane
13. Overtake a slow driver on the inside
14. Race away from traffic lights with the intention of beating the driver next to you
15. Drive so close to the car in front that it would be difficult to stop in an emergency
16. Cross a junction knowing that the traffic lights have already turned against you
17. Become angered by a certain type of a driver and indicate your hostility by whatever means you can
18. Underestimate the speed of an oncoming vehicle when overtaking
19. Disregard the speed limit on a motorway

About your driving style [Driving Style Questionnaire; DSQ]

Please indicate the option that applies to you for each question.

Never or very infrequently	Infrequently	Quite infrequently	Quite frequently	Frequently	Very

1. Sometimes when driving, things happen very quickly. Do you remain calm in such situations?
2. Do you plan long journeys in advance, including places to stop and rest?
3. Do you dislike people giving you advice about your driving?
4. Do you exceed the 70 mph limit during a motorway journey?
5. Do you ever drive through a traffic light after it has turned to red?
6. Do you exceed the speed limit in built up areas?
7. Do you ignore passengers urging you to change your speed?
8. Do you become flustered when faced with sudden dangers while driving?
9. How often do you set out on an unfamiliar journey without first looking at a map?
10. Are you happy to receive advice from people about your driving?
11. Do you drive cautiously?
12. Do you find it easy to ignore distractions while driving?
13. Do you drive fast?
14. Do you overtake on the inside lane of a dual carriageway if you have the opportunity?
15. Is your driving affected by pressure from other motorists?

Your view towards causes of road accidents [Traffic Locus of Control; T-LOC]

Below is a list of possible causes of road accidents. Please indicate how possible each item would be to cause a road accident considering your own driving. Please place a tick on an option per line.

Not at all possible	Not fairly possible	Possible	Fairly possible	Highly possible

1. Whether or not I would get into a car accident depends mostly on:
2. shortcomings in my driving skills
3. my own risk-taking while driving
4. shortcomings in other drivers' driving skills
5. other drivers' risk-taking while driving
6. bad luck
7. dangerous roads
8. if I drive too fast
9. if other drivers drive too fast
10. if I drive too close to the car in front
11. if other drivers drive too close to my car
12. fate
13. bad weather or lighting conditions
14. a mechanical failure in the car
15. other drivers driving under influence of alcohol
16. other drivers' dangerous overtaking
17. my own dangerous overtaking
18. coincidence

About your personality [Arnett Inventory of Sensation Seeking; AISS]

For each item, please indicate which response best applies to you. Please place a tick on an option per line.

Does not describe me at all	Does not describe me very well	Describes me somewhat	Describes me very well

1. I can see how it would be interesting to marry someone from a foreign country
2. When the water is very cold, I prefer not to swim even if it is a hot day
3. If I have to wait in a long line, I'm usually patient about it
4. When I listen to music, I like it to be loud
5. When taking a trip, I think it is best to make as few plans as possible and just take it as it comes
6. I stay away from movies that are said to be frightening or highly suspenseful
7. I think it's fun and exciting to perform or speak before a group
8. If I were to go to an amusement park, I would prefer to ride the rollercoaster or other fast rides
9. I would like to travel to places that are strange and far away
10. I would never like to gamble with money, even if I could afford it
11. I would have enjoyed being one of the first explorers of an unknown land
12. I like a movie where there are a lot of explosions and car chases
13. I don't like extremely hot and spicy foods
14. In general, I work better when I'm under pressure
15. I often like to have the radio or TV on while I'm doing something else, such as reading or cleaning up
16. It would be interesting to see a car accident happen
17. I think it's best to order something familiar when eating in a restaurant
18. I like the feeling of standing next to the edge on a high place and looking down.
19. If it were possible to visit another planet or the moon for free, I would be among the first in line to sign up
20. I can see how it must be exciting to be in a battle during a war

About your driving history

- How many at-fault road accidents (i.e. you hit another road user or an obstacle) have you been involved in as a driver during the last 5 years? ___________ ;
- How many of which required you to seek hospital treatment? __________
- How many non-fault accidents (i.e. you were hit by another road user) have you been involved in as a driver during the last 5 years? __________ ;
- How many of which required you to seek hospital treatment? __________

How often have you been involved in the following traffic offences in the past 5 years? Please note that this does **not** ask how often you were "caught", either by a Police Officer or automated enforcement means, for the traffic offences.

Never or very infrequently	Hardly ever	Occasionally	Quite often	Frequently	Very often

1. Speeding
2. Non-use of a seat-belt
3. Failing to stop at a red traffic light
4. Drink-driving
5. Driving under the influence of drugs
6. Use of a forbidden lane
7. Illegally using a mobile telephone or any other communication devices while driving

About your vehicle equipment

What Advanced Driving Assistance Systems is your vehicle equipped with by the manufacturer? Please tick each system that your vehicle is equipped with

☐ Cruise Control/Speed Limiter **Answer Y (yes) or N (no)**

☐ Lane Departure Warning system **Answer Y (yes) or N (no)**

☐ Automatic head Lamp **Answer Y (yes) or N (no)**

☐ Park assist **Answer Y (yes) or N (no)**

Have you installed any other driving assistance system in your vehicle? Please tick for each system your vehicle is equipped with

☐ After-market park assist system **Answer Y (yes) or N (no)**

☐ Others (please describe the systems) **..................**

About use of your nomadic devices while driving

For each situation described in the table below, please indicate how often each has applied to you in the last three months. Please tick one option per line.

Never or very infrequently	Hardly ever	Occasionally	Quite often	Frequently	Nearly all of the time

1. Do you connect your smart phone with your car by BlueTooth connection?
2. Do you use headset with your phone while you drive?
3. Do you use a navigation system while you drive?
4. Do you use an MP3/iPod /USB music system while you drive?
5. Do you use any other auxiliary device while you drive?

About use of driving assistance system

For each situation described in the table below, please indicate how often each situation has applied to you in the last three months. Please tick one option per line (or leave blank if your vehicle does not have this system).

Never or very infrequently	Hardly ever	Occasionally	Quite often	Frequently	Nearly all of the time

1. Do you use the speed limiter?
2. Do you use the cruise control?
3. Do you switch off the lane departure warning system?
4. Do you switch off the automatic head lamp system?
5. Do you switch off the automatic park assist?

Your driving experience

How many years have you been driving?

- 3 years or less
- More than 3 years

Appendix B: Cluster analysis

The aim of the cluster analysis was to identify whether the UK drivers could be classified into distinct groups based on their responses to the personality and attitudinal questionnaires. We hoped that the resulting clusters would be found to have differing behaviours in terms of their propensity to engage in non-driving-related activities.

The clustering approach was chosen as it was more nuanced than using the responses from the drivers on single factors or even combing multiple scores into a single scale as had been done in the UDRIVE project analysis. The risk with the simpler approach was that single factors might be given undue weight, thus potentially reducing the power of the prediction of behaviour, while hiding the fact that the groups might not in reality be homogeneous. The clustering approach was supported by the fact that the road safety literature has demonstrated that drivers' attitudes and their underlying motivation play a significant role in the engagement in risky driving behaviour (see e.g. Parker et al., 1998; Elliott, 2002; Anable, 2002; Gras et al., 2006). Thus, a causal link between attitudes and behaviour has previously been established.

Data screening

Before running the analysis, the data was made suitable to use by cleaning. Out of 53 UK drivers, the data of three drivers with no responses the questionnaires were removed. A new variable was computed to reflect the 'Use of Nomadic Device' among participants by adding the individual's responses on usage of the various devices. For this purpose, the responses on use of each type of device from "Never" to "Nearly all time" were converted to numerical scores of 1,2,3,4,5,6 and then summed, to give a possible maximum score of 30.

Rationale for choice of clustering variables

Out of the five self-reported personality metrics presented to the participants including DAQ, DBQ, DSA, TLOC and AISS, it was decided to select the TLOC and AISS factors as clustering variables. DAQ was excluded because, as used in UDRIVE, it only tapped into respondents' attitudes towards speeding and close following. DBQ ascertained the frequency of committing various risky behaviours, and was thus through not to be directly relevant to underlying personality and attitudinal factors, while DSQ similarly ascertained how drivers typically responded in various scenarios related to speeding, travelling with passengers, etc. Thus, DBQ and DSQ can be considered to address behaviour rather than attitudes.

Pre-requisites: multi-collinearity and criterion validity assessment

To assess the suitability of selected variables for clustering, the following checks were made:

1. Pre-analysis collinearity assessment: the four factors of TLOC and two factors of AISS were subjected to a check for multi-collinearity. No high correlations were observed among any of the variables.
2. Criterion validity: the selected questionnaires were then further subjected to criterion validity check to ensure their suitability in terms of predicting the output variables (i.e. accident involvement, use of mobile phone and use of nomadic devices, DBQ). Only the TLOC indices were found to have a correlation (significant but weak) with the outcome

variables. Thus, it was decided to perform the analysis with TLOC indices alone and not to include the AISS factors as clustering variables.

Analysis

Cluster analysis offers numerous ways to sort cases into groups including hierarchical clustering, k-mean clustering, and two-step clustering (Hair et al., 2006; Batool, 2012). A two-stage cluster analysis approach, agglomerative hierarchical clustering and non-hierarchical k-mean clustering analysis, was adopted for this research. As there was no prior knowledge of how many groups were present or even whether there were any clusters in the data, it was decided to first explore structure in data using hierarchical clustering. For this, the data was grouped using Euclidean Distance. Inspection of dendogram (see Figure 12) produced by the analysis along with scree plot, suggested 4, 3 and 2-cluster solutions. F-Ratio calculations were made for all three clustering solutions (see Table 16).

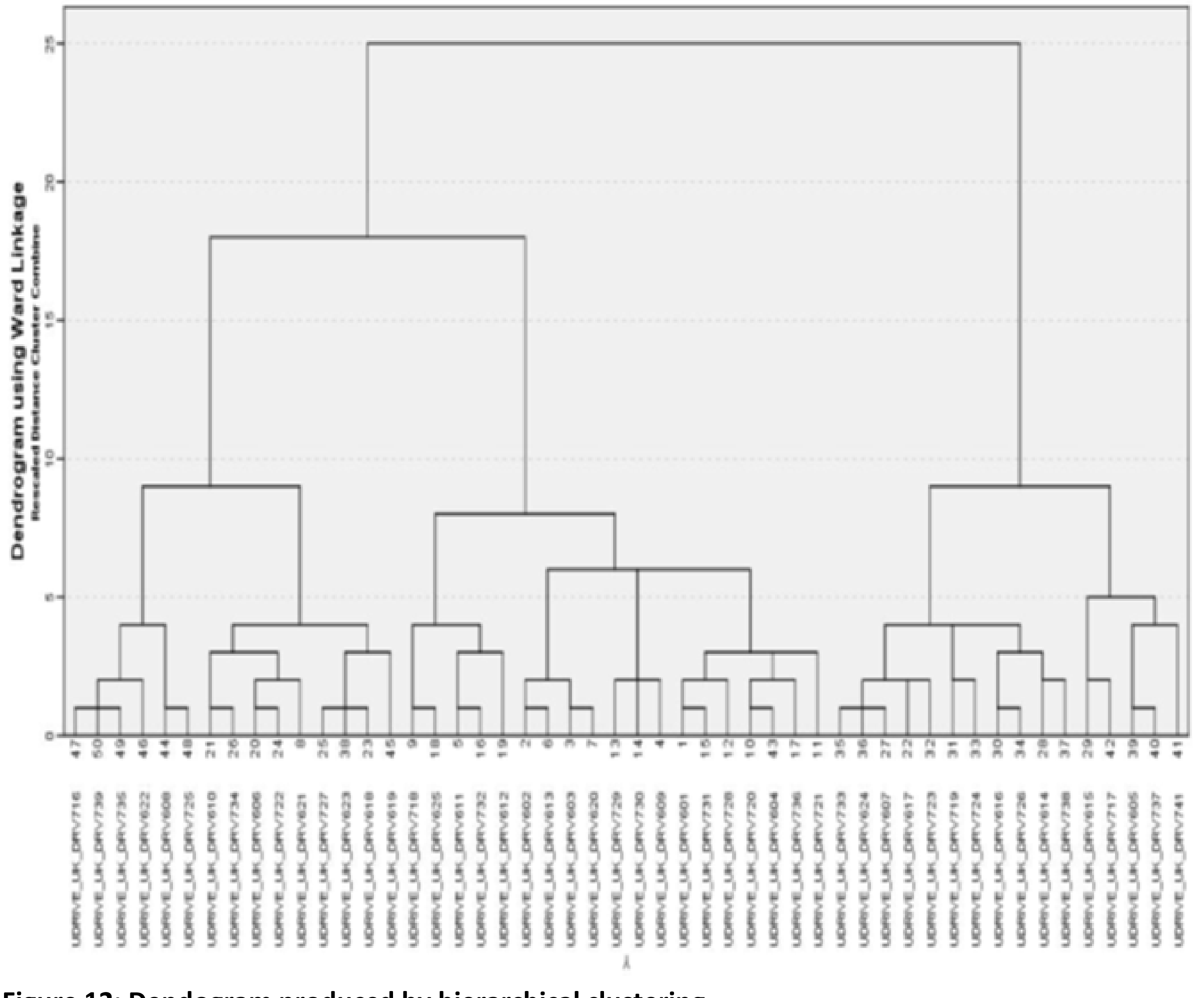

Figure 12: Dendogram produced by hierarchical clustering

Table 16: F-Ratio calculation for different clustering solutions; a 4-, 3- and 2-cluster solution is shown.

Factors	4-cluster	3-clusters	2-clusters
TLOC-self	11.68	17.78	36.25
TLOC-other	10.8	20.24	31.79
TLOC-vehicle	15.41	19.28	23.17
TLOC-fate	47.41	31.79	5.13
Sum	85.93	94.13	96.34

There was a choice of cluster solutions: two versus three versus four. The four-cluster solution had a lower F-ratio value. The discriminant analysis indicated three clusters, as did observation of the scree plot. In addition, examination of the power of the clusters to explain relevant dependent variables favoured the three-cluster solution.

After establishing the optimum number of clusters for the UK sample as three, the k-means iterative partitioning method was used to further to 'fine tune' the exploratory analysis and to get stable and distinct homogenous sub-groups. Table 17 shows the extracted groups with their mean scores on the TLOC factors, the standard deviation of those scores and from which other cluster(s) each cluster was different (based on post hoc testing).

Table 17: Personality characteristics of the segments. Mean (Standard deviation) and [clusters which differ significantly) are shown for each comparison of cluster scores on a single TLOC sub-scale

Factors	Cluster 1 (n=15)	Cluster 2 (n=19)	Cluster 3 (n=16)
TLOC-self	2.33 (.579) [2,3]	3.52 (.509) [1]	3.08 (.644) [1]
TLOC-other	3.47 (.520) [2,3]	4.26 (.472) [1]	4.43 (.339) [1]
TLOC-vehicle	2.78 (.349) [2,3]	3.58 (.627) [1]	3.92 (.524) [1]
TLOC-fate	2.53 (.732) [2]	1.58 (.428) [1,3]	3.02 (.463) [2]

To validate the extracted solution, multiple discriminant analysis was performed. The technique helped to establish that the extracted clusters were distinguishable from each other as can be seen in Figure 13 .

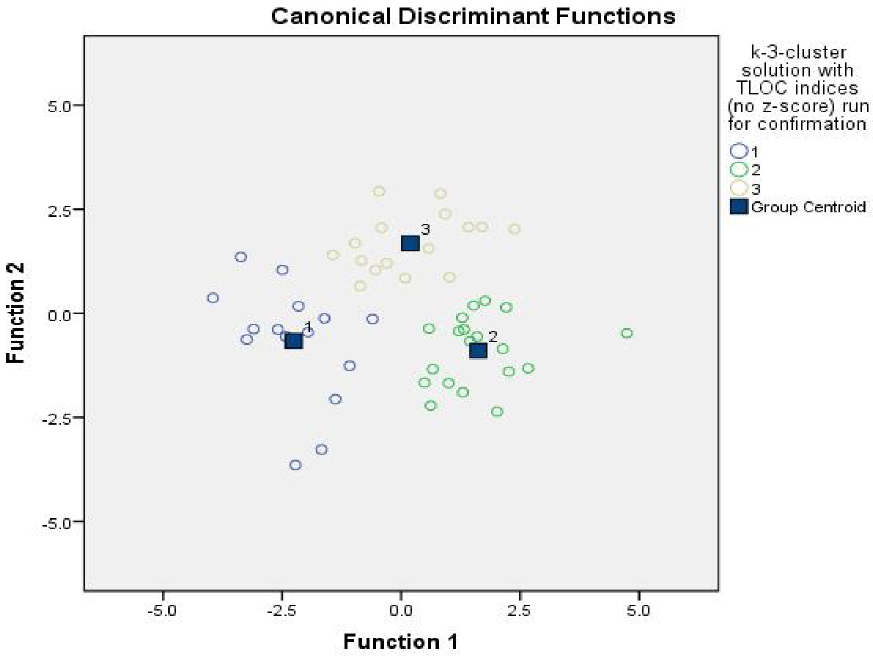

Figure 13: Clusters as determined by discriminant functions

The last stage of the analysis was profiling of the clusters. The clusters were profiled in terms of their demographic characteristics, driving-related factors and their responses to the non-TLOC questionnaires, including DAQ, DBQ, AISS. This helped to understand the relationship between the segmentation and other attitudinal and behavioural factors. Table 18 provides information about the driving and demographic composition of the groups. Table 19 summarises self-reported responses of drivers on the different personality questionnaires administered in the study.

Table 18: Driving and demographic profile of the clusters.

Factors	Cluster 1 (n=15)	Cluster 2 (n=19)	Cluster 3 (n=16)
Age *(not significant)*	43.23 (18.12)	48.96 (12.18)	41.74 (12.53)
Gender *(not significant)*	8 males; 7 females	10 males; 9 females	7 males; 9 females
Driving experience *(significant)*	4 (0-3); 11 (>3)	0 (0-3); 19 (>3)	1 (0-3); 15 (>3)
Accident involvement *(significant)*	.79 (1.188)	.16 (.375)	.25 (.577)
Drink driving *(not significant)*	1	1	1.13 (.342)
Use of mobile phone *(not significant)*	1.21 (.426)	1.47 (.841)	1.69 (1.448)
Use of nomadic devices *(not significant)*	10.50 (3.86)	11.58 (4.54)	10.56 (4.77)

Table 19: Profiling of the clusters based on dimensions of their self-reported driving personality.

Factors	Cluster 1 (n=15)	Cluster 2 (n=19)	Cluster 3 (n=16)
Arnett Inventory of Sensation Seeking (AISS)			
AISS-novelty	16.33 (27.142)	25.05 (4.813)	26.75 (4.09)
AISS-intensity	22.87 (5.680)	23.05 (5.233)	24.69 (3.945)
AISS-overall	39.20 (27.680)	48.11 (8.110)	51.44 (6.110)
Driver Skills Questionnaire (DSQ)			
DSQ12 (avoiding distractions)	4.64 (1.082)	3.89 (1.197)	4.31 (1.014)
DSQ-speed	7.79 (2.326)	8.95 (3.674)	8.81 (2.949)
DSQ-calmness	14.71 (2.054)	13.53 (2.568)	13.88 (2.363)

DSQ-social resistance	6.64 (1.946)	7.84 (2.192)	6.94 (2.489)
DSQ-focus	11.38 (2.873)	11.74 (3.160)	12.00 (2.686)
DSQ-planning	8.29 (3.245)	8.84 (2.035)	9.31 (2.701)
DSQ-deviance	2.64 (1.151)	3.05 (1.079)	3.19 (1.377)
Driver Attitude Questionnaire (DAQ)			
DAQ overall	77.14 (7.715)	71.32 (9.810)	72.44 (8.390)
Driver Behaviour Questionnaire (DBQ)			
DBQ-errors	1.57 (.480)	1.73 (.351)	1.79 (.325)
DBQ-aggressive violations	1.72 (.606)	1.91 (.607)	1.87 (.589)
DBQ-ordinary violations	1.70 (.391)	2.04 (.594)	2.13 (.559)
DBQ-overall	1.70 (.388)	2.00 (.489)	2.06 (.504)

Finally, to analyse the effect of countries on personality profiles of drivers, k-means non-hierarchical clustering with three-cluster solution was run for the rest of the EU data. The analyses generated three groups holding distinct profiles. All dimensions of TLOC significantly contributed to define the clusters. Table 20 summarises the results with information about the countries of each of group of drivers. The Polish drivers were most likely to fall into Cluster 1, which blamed fate as being responsible. It can be noted that, as reported in UDRIVE, Polish drivers were most prone to engage in distracting tasks, including mobile phone use.

Table 20: The effect of country on personality profiles of drivers – Clustering of non-UK EU drivers

Factors	Cluster 1 (n=50)	Cluster 2 (n=50)	Cluster 3 (n=37)
TLOC-self	2.83 (.75) [2,3]	2.02 (.59) [1,3]	3.51 (.78) [1,2]
TLOC-other	4.15 (.48) [2]	3.34 (.62) [1,3]	4.26 (.46) [2]
TLOC-vehicle	3.71 (.58) [1]	2.77 (.65) [1,3]	3.48 (.68) [2]
TLOC-fate	3.42 (.61) [2,3]	2.43 (.58) [,3]	1.68 (.52) [1,2]
Countries			
France (40)	18	11	11
Poland (36)	17	10	9
Netherlands (31)	8	22	1
Germany (29)	6	7	16

Appendix C: Secondary task coding scheme

Pass A Annotations

Value	Category	Description	Annotation start	Annotation end
0	No_Task	The driver is not engaged in any observable secondary tasks and is attentive to the driving task.	Start of record (value set by default in the annotation panel)	. start of other secondary task ***OR*** .end of record
1	Phone	The driver is interacting with a cell phone. All types of interaction count: • locating/searching; • holding it in hand, lap, or some other way; • pressing buttons; • talking; • navigating (the phone is placed somewhere and the driver looks to it frequently; the cell phone display is always on and does not go to standby mode); • putting it away. If the driver is moving the lips and it is not clear if he/she is singing, talking with a passenger or talking on a hands-free phone, annotate as 99 = Talking_Singing_Audience_Unknown (description below).	First glance or hand movement towards the cell phone. Code whichever occurred first.	. phone is put down ***OR*** . last hand movement to end the call ***OR*** . first sign that conversation has ended (e.g. lips do not move anymore).
2	Electronic_Device	The driver is interacting with an electronic device. An electronic device can be: iPad, CB Radio or other intercom system, calculator, camera or a nomadic GPS. Annotate only electronic devices that are **<u>not</u>** integral to the vehicle. All types of interaction count: locating/searching; reaching or starting to glance around; manual interaction (with finger or stylus); visual interaction; putting away. **<u>Attention!</u>** If the driver is interacting with an unknown device annotate this as 999 = Unknown.  → *What is a CB RADIO?* *Citizens' band radio* - a system of short-distance radio communications between individuals → *What is a Stylus?* A small pen-shaped instrument that is used to input commands to a computer screen, mobile device or graphics tablet 	First glance or hand movement towards the device. Code whichever occurred first.	. device is put down ***OR*** . last hand movement to end interaction with device ***OR*** . first sign that vocal interaction has ended (e.g. lips do not move anymore)

3	Food_Drink	The driver is performing an action with a/towards a food-related or drink-related item. E.g.: reaching for cup, utensils, plate or food; eating/drinking with and without utensils; putting utensils or food away. **Attention!** Chewing only does not count as a secondary task (e.g. chewing gum). However, if driver reaches for chewing gum, this has to be counted as a Food_Drink secondary task that ends when the driver puts away the chewing gum package.	First glance to or movement towards the food/drink-related item. Code whichever occurred first.	. driver's hand releases item for the last time
4	Smoking	The driver is glancing around for, reaching, lighting, smoking or extinguishing a cigar/cigarette. The interaction with smoking related items should also be annotated in this category. **Attention!** If the driver is chewing tobacco and tobacco is simply in mouth during the analysis window, do not annotate as a secondary task. If the driver is reaching, spitting, putting it away, then annotate as 4=Smoking (same principle as for chewing gum).	First glance to or movement towards the cigar/cigarette or related item. Code whichever occurred first.	. discards the cigar/cigarette or related device ***OR***
5	Reading_Writing	The driver is reading material that is in the vehicle, but not a part of the vehicle (i.e., not reading external signs, or centre stack display). This could be reading directions, paper material, and packaging. If driver is reading a phone number on a cell phone or reading in a tablet annotate this in 1=Phone or 2=Electronic_Device, respectively.	First eye glance towards the reading material or first physical motion towards the reading material. Code whichever occurred first.	. puts down the reading material ***OR*** . the driver does not perform glances towards the reading material for at least 30s
6	Personal_Grooming	The driver interacts with any item related to personal hygiene, health, or adornment. This includes: reaching for comb, brush, make-up, razor, dental floss, contact lenses, glasses (not currently being worn), hat (not currently being worn). Removing, adjusting, or putting on clothing or jewellery are also included in this category. **Attention!** If the driver quickly swipes hair out of eyes or idles twirling of hair this should **<u>not</u>** be annotated. Personal grooming activities are annotated if the driver has an object in the hand. If there is not object it should not be annotated. An exception is if driver is e.g. looking in the rear-view mirror to remove something/contact lens from the eye. swiping hair out of eyes idle twirling of hair	First glance to or movement towards the object. Code whichever occurred first.	. puts the object down ***OR*** . last glance towards the mirror to end personal grooming action (e.g. verifies makeup, hair, adjusting scarf or hat …)
99	Talking_Singing_Audience_Unknown	The driver is moving the lips but it is not clear if he/she is singing or talking on a phone using a hands-free device (headset, in-vehicle integrated system, or hands-free speaker phone). **Attention!** If it's clear that the driver sings or talks with a passenger this should not be annotated	First lips movement.	.first sign that conversation/singing has ended (e.g. lips do not move anymore)

999	Unknown	Use this category when the driver is doing something that cannot be clearly identified ***OR*** interacting with a non-identifiable object. **Attention!** Do not use this category for tasks that should not be annotated. These are described below (in point 7 – important notes).		

Pass B Annotations

PHONE

Value	Category	Description	Annotation start	Annotation end
1	P_Search	The following actions are included: glancing to find the cell phone, reaching towards his/her cell phone, and/or flipping phone open or pressing a button to answer a call. This category should finish when the driver has answered the cell phone. flipping phone open – (D) Handy aufklappen	First glance towards or hand movement towards the phone. Code whichever occurred first.	. phone is in driver's possession ***OR*** . conversation has begun ***OR*** . start of another category (e.g. hold, interaction, reading, or even put the phone down)
2	P_HHeld_Conversation	The driver is talking on a handheld phone or has phone up to ear as if listening to a phone conversation or waiting for person they are calling to pick up the phone.	Button press to answer call or if not visible, first mouth movement of call	. Button press to hang up phone ***OR*** . put down the phone
3	P_HFree_Conversation	The driver is talking or listening on a phone using a hands-free device such as a headset, in-vehicle integrated system, or hands-free speaker phone. If driver has an earpiece or headset, the driver must be observed talking repeatedly.	. headset or in-vehicle system button press to answer ***OR*** . first mouth movement of call using handsfree or headset system	. last mouth movement of call ***OR*** . button push to end call
4	P_Hold	The driver is holding a cell phone but not manipulating it. Could be holding it in hand, lap, or some other way.	First body contact with phone not considered to be reaching for or interacting with it.	. phone is put down ***OR*** . start of another phone category
5	P_HHeld_Interaction	The driver is pressing buttons or a touch screen on the cell phone. The driver can be writing a text message, browsing the internet, or interacting with other phone applications. These are mainly physical interactions (e.g. with finger) that will alternate with small pauses (just looking, looking back to the road).	First hand movement across phone screen	. last hand movement across phone screen

6	P_Handheld_reading	Subject vehicle driver is looking at the screen and clearly reading it, without a physical interaction. If there is a physical interaction with the phone this should be annotated as interaction.	First glance towards screen (>1s)	Looks away from screen (>5s)
7	P_HFree_Interaction	The driver looks to the cell phone regularly without holding it. It can happen if drivers receive navigation instructions using the cell phone.		
8	P_Related	Subject vehicle driver is interacting with a cell phone in some manner. Includes plugging phone into charger, cleaning screen, putting on headset, etc.	First manual contact with phone-related item e.g. charger	. last manual contact with phone-related item e.g. charger

Appendix D: Mobile phone sub-task interactions per driver cluster

Table 21: Phone use categories per driver ID

Cluster	Handheld Conversation	Handheld Interaction	Handheld Reading	Phone Search	Phone Holding	Hands-free Conversation	Hands-free Interaction	Phone Use Categories	Hands-free Only
1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7	×
	Yes	Yes	Yes	Yes	Yes	No	Yes	6	×
	No	Yes	Yes	Yes	Yes	No	No	4	×
	No	Yes	No	Yes	Yes	No	No	3	×
	No	Yes	No	Yes	Yes	No	No	3	×
	No	Yes	No	Yes	No	Yes	No	3	×
	No	Yes	No	No	No	No	Yes	2	×
	No	No	No	Yes	No	No	No	1	×
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
2	No	Yes	Yes	Yes	Yes	Yes	Yes	6	×
	Yes	Yes	Yes	Yes	Yes	No	No	5	×
	No	Yes	Yes	Yes	Yes	No	Yes	5	×
	Yes	Yes	No	Yes	Yes	No	Yes	5	×
	No	Yes	No	Yes	Yes	No	Yes	4	×
	Yes	Yes	No	Yes	Yes	No	No	4	×
	Yes	Yes	No	Yes	Yes	No	No	4	×
	Yes	Yes	No	Yes	Yes	No	No	4	×
	No	Yes	No	Yes	Yes	No	No	3	×
	No	Yes	No	Yes	No	No	No	2	×
	No	No	No	No	No	No	Yes	1	✓
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
3	No	Yes	Yes	Yes	Yes	Yes	Yes	6	×
	No	Yes	Yes	Yes	Yes	Yes	Yes	6	×
	No	Yes	Yes	Yes	Yes	No	Yes	5	×
	No	Yes	Yes	Yes	Yes	No	No	4	×
	No	Yes	Yes	Yes	Yes	No	No	4	×
	No	Yes	Yes	Yes	Yes	No	No	4	×
	Yes	Yes	No	Yes	Yes	No	No	4	×
	No	Yes	Yes	Yes	Yes	No	No	4	×
	No	Yes	No	Yes	Yes	No	No	3	×
	No	Yes	No	Yes	Yes	No	No	3	×
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA
	No	No	No	No	No	No	No	0	NA

Table 21 shows mobile phone use across the entire UK sample, broken down per mobile phone sub-task. There are drivers in all clusters who did not engage in any form of mobile phone use. So, while personality variables offer some predictive value in whether a driver engages with distraction in the sample, several other factors also influenced the occurrence of this behaviour.

Appendix E: Regulation 110 of the Construction and Use Regulations 1986, as amended in 2003

These regulations have been used in this work to identify illegal handheld phone use.

Mobile telephones

110.—(1) No person shall drive a motor vehicle on a road if he is using—

(a) a hand-held mobile telephone; or
(b) a hand-held device of a kind specified in paragraph (4).

(2) No person shall cause or permit any other person to drive a motor vehicle on a road while that other person is using—

(a) a hand-held mobile telephone; or
(b) a hand-held device of a kind specified in paragraph (4).

(3) No person shall supervise a holder of a provisional licence if the person supervising is using—

(a) a hand-held mobile telephone; or
(b) a hand-held device of a kind specified in paragraph (4), at a time when the provisional licence holder is driving a motor vehicle on a road.

(4) A device referred to in paragraphs (1)(b), (2)(b) and (3)(b) is a device, other than a two-way radio, which performs an interactive communication function by transmitting and receiving data.

(5) A person does not contravene a provision of this regulation if, at the time of the alleged contravention—

(a) he is using the telephone or other device to call the police, fire, ambulance or other emergency service on 112 or 999;
(b) he is acting in response to a genuine emergency; and
(c) it is unsafe or impracticable for him to cease driving in order to make the call (or, in the case of an alleged contravention of paragraph (3)(b), for the provisional licence holder to cease driving while the call was being made).

(6) For the purposes of this regulation—

(a) a mobile telephone or other device is to be treated as hand-held if it is, or must be, held at some point during the course of making or receiving a call or performing any other interactive communication function;
(b) a person supervises the holder of a provisional licence if he does so pursuant to a condition imposed on that licence holder prescribed under section 97(3)(a) of the Road Traffic Act 1988 (grant of provisional licence);
(c) "interactive communication function" includes the following:
    (i) sending or receiving oral or written messages;
    (ii) sending or receiving facsimile documents;
    (iii) sending or receiving still or moving images; and
    (iv) providing access to the internet;

(d) “two-way radio” means any wireless telegraphy apparatus which is designed or adapted—
   (i) for the purpose of transmitting and receiving spoken messages; and
   (ii) to operate on any frequency other than 880 MHz to 915 MHz, 925 MHz to 960 MHz, 1710 MHz to 1785 MHz, 1805 MHz to 1880 MHz, 1900 MHz to 1980 MHz or 2110 MHz to 2170 MHz; and

(e) “wireless telegraphy” has the same meaning as in section 19(1) of the Wireless Telegraphy Act 1949.”

Driver's control

104. No person shall drive or cause or permit any other person to drive, a motor vehicle on a road if he is in such a position that he cannot have proper control of the vehicle or have a full view of the road and traffic ahead.

Appendix F: Country and personality

Cluster analysis was also performed on personality data of all European passenger car drivers from the UDRIVE project, to understand the effect of country on driver behaviour. The data was subjected to a three-cluster solution (Clusters A, B and C). Note, these clusters have different characteristics to the cluster analysis of the UK-only sample. Again, the limited sample size used in this analysis should be considered before extrapolating to these findings to European drivers as an entire population.

Cluster A drivers were found to blame external factors more compared to themselves in accident causation. This group had the highest percentages of French and Polish drivers.

Cluster B appeared to have the lowest self-blaming attitude. However, at the same time, the cluster also did not find blaming external factors for crashes. This group had the highest percentage of Dutch drivers in it.

Cluster C reported the highest self-blaming and lowest fate-blaming orientation. This was the group containing highest percentage of German drivers. The comparison of groups' personality orientation with their naturalistic data reconfirmed that personality influence the behaviour up to an extent. For instance, German drivers showed the lowest prevalence of secondary task interaction overall (Table 22), and for mobile phone use.

Table 22: Secondary task interaction per country

Country	Trips with secondary task (%)
UK	53
Germany	30
France	42
Netherlands	53
Poland	57