# TOWARDS QUANTIFYING ROAD RISK: A CASE OF DISTRACTED DRIVING

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## ABSTRACT

Despite the current road safety situation in South Africa, to date it has been difficult to quantify the degree to which road users in South Africa are at risk of being involved in road traffic crashes. Naturalistic driving studies investigate driver behaviour within the driving context, over a long-term. The expectation is that the behaviour observed over this period of time will be reflective of behaviour over a longer time which will provide insight into factors associated with crash causation, near-misses and incidents. The result is detailed data that gives insight into driver behaviour over a long term. The benefit of this methodology is that in addition to “big” events such as crashes, near-misses and so forth, data pertaining to mostly unreported or seemingly insignificant events is also recoded and available for analysis.

This study made use of naturalistic driving data collected from four primary drivers in 2014 to conduct a further analysis of an additional two hours of data previously collected for experienced drivers considering prevalence, type, frequency and duration of distracted driving behaviour in urban areas.

The purpose of the exercise was to further expand the use of the NDS methodology by adding additional coders, independently verify the results from coders in order to show that it is possible to quantify and measure unsafe road usage in South Africa.

## 1. Introduction

Naturalistic driving studies (NDS) are longitudinal experiments that investigate driver behaviour over a long-term. The rationale behind the methodology is that the driver will not try to significantly alter his driving behaviour for the duration of the experiment. The expectation is that the behaviour observed over this period of time will be reflective of behaviour over a longer time which will provide insight into factors associated with crash causation, near-misses and incidents. The primary objective thus is to record events of varying degrees. The result is detailed data that gives insight into driver behaviour over a long term. The benefit of this methodology is that in addition to “big” events such as crashes, near-misses and so forth, data pertaining to mostly unreported or seemingly insignificant events is also recoded and available for analysis

The Naturalistic Driving Study methodology allows for the investigation and examination of detailed driver actions at a microsecond level. The use of cameras (front-facing the road/facing the driver and the back of vehicle) as well as an on-board computer collecting vehicle parameters (speed, acceleration, deceleration etc.) allows for the collection of rich qualitative and quantitative data that provide insight into driver behaviour within specific road contexts.

## 2. Background

The Council for Scientific and Industrial Research has since 2012 been exploring the use of the NDS methodology for exploring a range of driver behaviour topics. In 2013 over two-hundred hours of naturalistic driving data (NDD) was collected from 4 primary drivers.

In 2016, the second week of driving data for each of the four drivers was selected for analysis to investigate the prevalence of distracted and inattentive driving (Venter, Labuschagne, Phasha, Gxowa and Khoza, 2016).The selected imagery was transcribed and analysed in qualitative analysis software (MaxQDA©). A predefined coding scheme (based on literature review) was used for the analysis of activities related to in-vehicle distractions. Approximately 7.4 hours of data were analysed.

## 3. Objective of the project

The 2016/17 project formed part of a capacity building exercise to work with the NDS methodology and data. Previously only one researcher was involved in the coding and analyses of the data that was collected. Two new coders (instead of the customary one) were trained to code the image material while a third verified that the coding scheme was applied consistently by both new coders. For the purpose of this study 2 additional hours of image material from the third driving week were selected and transcribed (for the female experienced driver) in search of evidence of distracted driving behaviour.

This project therefore aimed to show that it is possible to train new coders to consistently code the image material and that it is possible to quantify risk for South African road users utilising the NDS methodology. Although the scale of the research is small scale the findings has again highlighted the potential of utilising the NDS methodology for human factor research.

## 4. Rationale for using distracted driving as a project topic

The results from the Road Traffic Management Corporation Study (2016) highlighted distracted driving as a possible contributory factor that can potentially lead to road traffic crashes on South African roads. This study investigated inattentive and/or distracted driving, including mobile phone use, distraction by passengers and other in-vehicle behaviours. Indications were that each of the four drivers showed signs of general inattention and at least one type of distracted driving behaviour. The frequency with which these behaviours occur seems to be high, leading to the question whether inattentive driving has become the norm rather than the exception for South African drivers (Venter et al., 2016).

A coding scheme was prepared for the 2016 study and for training and verification purposes, this coding scheme was used by the coders to code the additional image materials.

## 2. METHODOLOGY

### 2.1. Overview of methodology

The coding scheme is a map that guides the coder through the data. The new coders started off with their initial coding using the 2016 distracted driving coding scheme and although the ideal is to have a coding scheme detailing all the various behaviours this has on more than one occasion proved to be insufficient as the elements of behaviour that needs to be coded differs from video clip to video clip and participant to participant. In-vivo coding (or coding as you go along) is necessary if all elements of the behaviour are to be captured. In-vivo coding in this instance contributed to the expansion of the original coding scheme and the expanded coding scheme will in future be used as the next base document scheme for coding distracted driving behaviour. In addition the coding schemes developed and applied by the two coders were fairly consistent and although a small sample, the research findings contributes information to a developing body of knowledge, for a collective understanding of risks and hazards in the South African road and traffic environment from a driver perspective.

The 2016 coding scheme was used to code the image material which were done by two different coders with an independent coder verifying the coding results.
Indicators used to identify distracted driving behaviour include (Basacik 2008):

- *Glance frequency* refers to the frequency with which the driver looks at something. The more frequently the driver's visual attention is drawn away from the primary task of driving the higher the likelihood that important changes in the driving environment are not sensed, and cannot be responded to.
- *Total glance time* refers to the total amount of time spent looking at distraction. The longer the driver spends looking away from the primary visual task, the higher the chance of an incident occurring to which the driver cannot respond swiftly
- *Maximum glance time* refers the longest period spent looking at something without glancing away. Larger glances away increase the chance that the driver will fail to detect changes in the driving environment and respond swiftly

## 2.2. Results

*2.2.1. Overview of data sets*
The datasets used to compile the two hours of NDD follow on each other and is a continuous set of NDD over the course of an hour. The two new coders had similar amounts of observations for an hour of driving material (table 1).

| TABLE 1: NUMBER OF OBSERVATION FOR ONE HOUR OF DRIVING PER CODER | |
|---|---|
| Coder 1 | Total |
| Number of observations | 338 |
| Length | 65 |
| Coder 2 | Total |
| Number of observations | 339 |
| Length (minutes) | 66 |

**Data set 1** consisted of 65 minutes of driving time analysed. A third of this driving time (99 of 338 observations) was considered normal driving by Coder 1. On average normal driver behaviour lasted for 35 seconds before the driver engaged in a secondary activity that is considered distracting. In 24 % of the time the driver engaged in behaviour not necessarily considered distracting but unsafe nonetheless, such as not having proper control over the vehicle (no hands or only one hand on the steering wheel or driving without a seatbelt).
The driver engaged in secondary activities considered distracted driving practice in 39 % of the time analysed. The most significant types of distracted driving behaviour observed in the two datasets were grooming, smoking and looking down or not paying attention to the road.

**Data set 2** consisted of 66 minutes of driving time analysed. A third of this driving time (106 of 339 observations) was considered normal driving by Coder 2. On average normal driver behaviour lasted for 23 seconds before the driver engaged in a secondary activity that is considered distracting. In 13.3% of the time the driver engaged in behaviour not necessarily considered distracting but unsafe nonetheless, such as not having proper control over the vehicle (no hands or only one hand on the steering wheel or driving without a seatbelt).
The driver engaged in secondary activities considered distracted driving practice in 40 % of the time analysed. In this dataset the most significant types of distracted driving behaviour

observed included smoking and looking down or not paying attention to the road followed by a passenger that caused distraction.

*2.2.2. Overview of analysis*

The analysis considered the frequency and duration of behaviour observed in the image material. In terms of broad behavioural categories coded (figure 3). Normal driving behaviour was observed for similar proportions of driving time.  External distractions were only coded by Coder 2, the more experienced coder. In-vehicle distractions were observed for 50 % of the driving time by Coder 1 and 37 % of the time by Coder 2 (Figure 1).

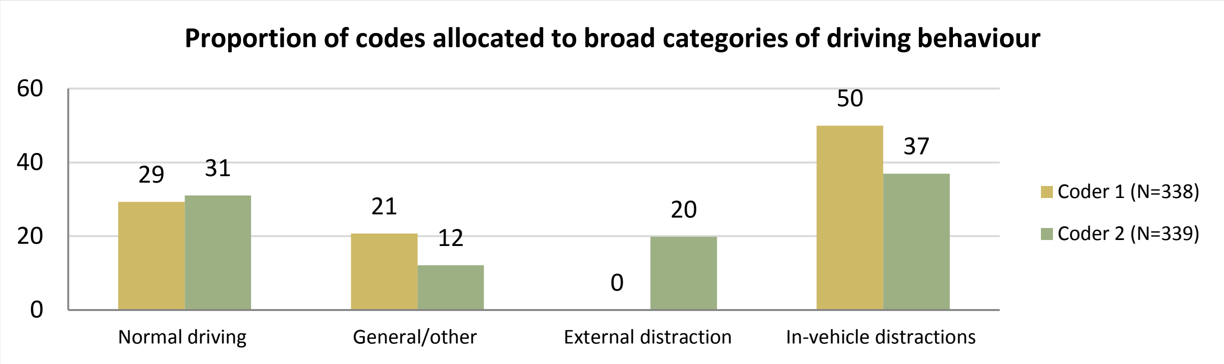


FIGURE 1: PROPORTION OF CODES ALLOCATED TO BROAD CATEGORIES OF DRIVING BEHAVIOUR

Normal driving behaviour include driving with both hands on the steering wheel, driver looking forward, observing side and rear-view mirror as well as standing still in traffic or reversing. External distractions were coded when the driver looked sideways. External distractions were not analysed further. General or other behaviour coded included driving without a seatbelt, driving with only one hand on the steering wheel and driving with no hands on the steering wheel. Although these behaviours are not considered distracting, they can potentially influence safe driving. In-vehicle distractions included: grooming (adjusting hair/sunglasses/ putting on make-up); smoking (reaching for / lighting a cigarette/ smoking the cigarette); dining (eating and drinking while driving); Mobile phone use (talking on phone holding handset/talking on hands-free set/ adjusting earphones/ texting while driving) and looking down at something in the vehicle.

*a) Normal behaviour*

Normal driving behaviour was observed for 31 % of the approximately one hour of driving by Coder 1 and 29 % of the time analysed by Coder 2. The average time spent on normal driving behaviour by the experienced driver was between 35 seconds (Coder 1) and 23 seconds (Coder 2). The maximum time spent on normal driving as observed by Coder 1 was approximately 4 minutes and by Coder 2, 6 minutes.

*b) Other types of behaviour observed*

General or other behaviour coded included driving without a seatbelt, driving with only one hand on the steering wheel and driving with no hands on the steering wheel. The coding differed for the two coders, with the exception of driving without a seatbelt, which was observed by both coders for approximately 1 % of the time. Coding of “driving with only one hand on the steering wheel” by Coder 1 (21.6 %) coincided with smoking behaviour.

*c) In-vehicle distractions: frequency and duration*

Table 2 provide a summary of the glance duration as well as time spent on distracting activities.

| TABLE 2: VISUAL INDICATORS OF DISTRACTION AND TIME SPENT ON SECONDARY ACTIVITIES. | | | | |
|---|---|---|---|---|
| **Behaviour** | **Coders** | **Performance measure/ indicator of visual distraction** (Basacik 2008) | | |
| | | **Frequency** | **Total time** | **Maximum duration** |
| Passenger as distraction | Coder 1 | n/a | n/a | n/a |
| | Coder 2 | 5 times/hour | 00:24:36 | 00:10:35 |
| Grooming | Coder 1 | 36 times/ hour | 00:02:07 | 00:00:14 |
| | Coder 2 | 18 times/ hour | 00:02:13 | 00:00:51 |
| Smoking | Coder 1 | 14 times/hour | n/a | n/a |
| | Coder 2 | 41 times/hour | n/a | n/a |
| Mobile phone use (handset) | Coder 1 | n/a | n/a | n/a |
| | Coder 2 | 7 times /hour | n/a | 00:06:56 |
| Mobile phone use (hands free set) | Coder 1 | 22 times /hour | n/a | n/a |
| | Coder 2 | 5 times /hour | n/a | n/a |
| Dining | Coder 1 | 9 times /hour | n/a | n/a |
| | Coder 2 | 4 times /hour | n/a | n/a |
| Looking down/Eyes not on road | Coder 1 | 32 times /hour | 00:03:14 | 00:00:40 |
| | Coder 2 | 48 times /hour | 00:03:33 | 00:00:50 |

Table 3 illustrates that in both data sets, distracting in-vehicle activities accounted for between 39 and 40 per cent of observations coded, consistent for both of the NDD sets analysed.

| TABLE 3: PROPORTION OF TIME SPENT ON OTHER TYPES OF POTENTIALLY UNSAFE BEHAVIOUR WHILE DRIVING | | |
|---|---|---|
| | Coder 1 | Coder 2 |
| Distracting activities | 130 | 135 |
| All observations | 338 | 339 |
| **% time coded for distracting activities** | **38.5** | **39.8** |

Figure 2 provide an overview of the different activities coded according to the sub-types of distracted driving activities. The frequency with which the driver engaged with the activities differed in the two data sets.

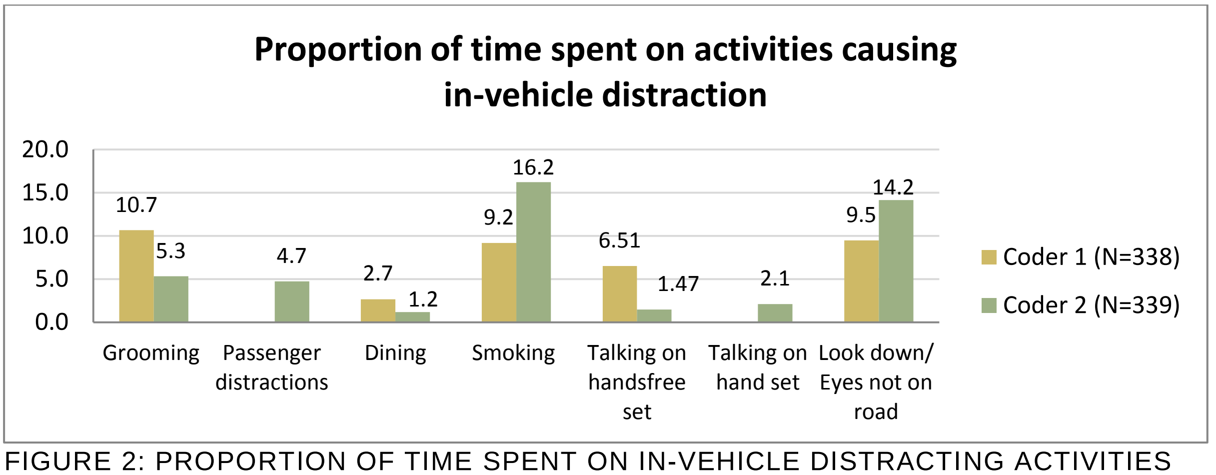


FIGURE 2: PROPORTION OF TIME SPENT ON IN-VEHICLE DISTRACTING ACTIVITIES

Coder 1 observed grooming behaviour as the most distracted driving behaviour followed by smoking and looking down or not observing the road. The most distracted driving behaviour observed by coder 2 was smoking (reaching for and lighting a cigarette and smoking the cigarette) followed by the driver looking down or not paying attention to the road.

Figure 3 provide an overview of the average duration of distracted driving activities coded by both coders in the two NDD sets.

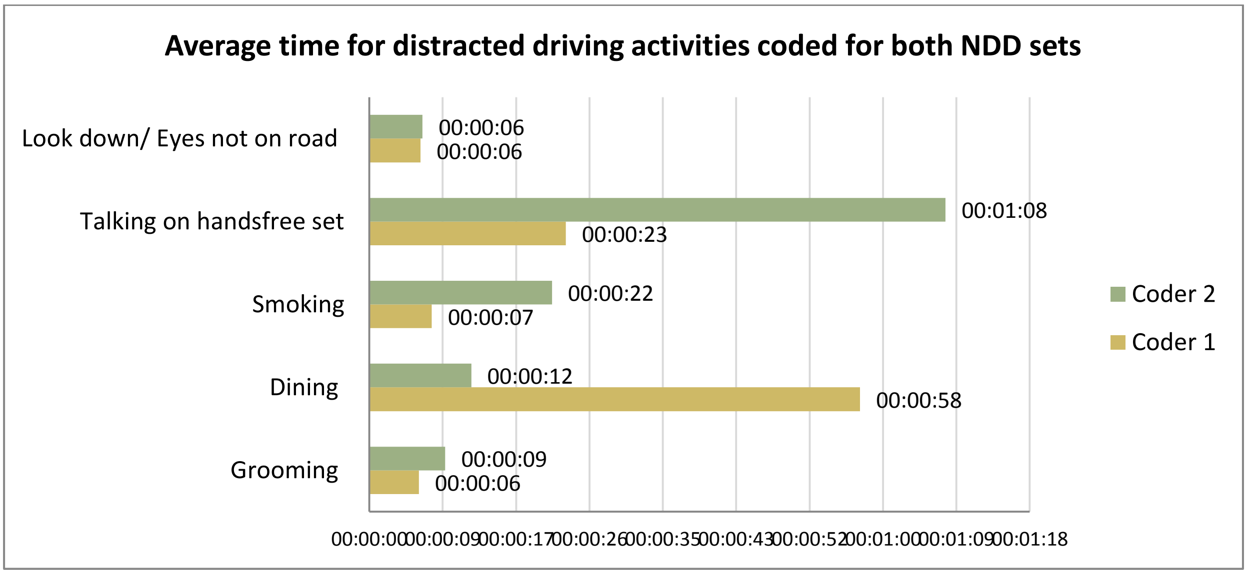


FIGURE 3: AVERAGE TIME CODED PER DISTRACTED DRIVING ACTIVITY FOR BOTH NDD SETS

In both data sets, coders allocated similar average times to the driver looking down or not paying attention to the road (6 seconds) and similar values for the duration of grooming activities (6 and 9 seconds respectively).

**d) Duration of distracted driving activities (not compared)**

Passengers as a distraction and talking on a mobile phone handset were observed by only Coder 2 and can therefore not be compared in terms duration allocated to the behaviours. Although these situations were not present in both datasets, the impact thereof on behaviour is still significant. Passengers as a distraction were observed in the one hour dataset for almost 5 % (sixteen observations) of time. The average duration of passenger distractions were approximately 7 minutes at a time.

Talking on a handheld phone was observed in the same dataset in 2.1 % (seven observations) of the time. The average time spent talking on the handheld phone was approximately one and a half minute at a time with the longest conversation being almost seven minutes.

## 3. PROFILE OF A DISTRACTED DRIVER AND IMPLICATIONS FOR SAFE DRIVING

### 3.1. Overview

Humans are serial information processors, meaning that humans are capable of doing only one task at a time (Mayhew 2003). By switching between tasks, no task receives the attention it should (Mayhew 2003). In this study, normal driving was on observed for 31 % of the driving time. This is significant as the implications are that the driver was engaged in other activities either distracting or in general considered unsafe instead of paying attention to the primary driving task. The results indicate that the time spent on “other activities” along with normal driving account for approximately half of the driving time (01:05:23) while the

rest of the driving time is associated with the driver enaging in secondary and distracted driving activities.
Distractions and inattention interfere with a drivers' ability to allocate attention to their immediate driving environment in order to perceive and assess risks. This inability has implications for safe driving behaviour as distraction or inattentiveness scatters the ability to safely perceive and react to hazards within the driving environment.
Internationally, distraction is a leading causal factor in crashes. Distraction is a cause in approximately twenty-five per cent of crashes, worldwide (British Columbia Ministry of Public Safety and Solicitor 2009). Sixty per cent of novice driver crashes occur within 6 seconds of the driver being distracted (Miller 2016). In the United Kingdom ( (Sullman 2012), a observational study highlight that 14.4 % of approximately 7 000 drivers were driving distracted. The most freqeunt type of distracted driving was talking to a passenger (7.4 %), using a mobile phone (2.2 %), and smoking (2.2 %). Dining behaviour occurred in 1.1 % of drivers, followed by adjusting controls (1.1 %), with the "other" category containing the remaining 0.9%. In terms of gender, the findings were the same for both males and females. In the USA, reports are that 36 % of crashes are preventable if distraction is not present (Marshall 2016).

Several factors complicate determining whether distraction was a cause in a crash (Basacik and Stevens, 2008). One of the reasons is that there is no standard definition of distraction (Basacik 2008). Green et al (2007) state that distraction may also include situations where the requirements of the driving task exceeds the individuals' mental ability to process information from the driving environment. Safe driving includes:

- Monitoring of the road and traffic environment (which includes pedestrians and other road users) and control of the vehicle
- Maintaining an appropriate degree of attention and vehicle control to maintain a reasonable safety margin allowing for unexpected events

Basacik and Stevens (2008) defines distraction as the diversion of attention away from activities required for safe driving events, activity, object, or person within or outside the vehicle (Basacik 2008). Distraction is considered to be "perception failure with respect to the law of large numbers" according to British Columbia Ministry of Public Safety and Solicitor (2009). No immediate connection between distraction and safety can be drawn unless a person actually experience the consequences thereof. However, research has shown that attention is diverted away from the driving taks and the law of large numbers dicates that a crash will occur, sooner or later (British Columbia Ministry of Public Safety and Solicitor 2009).

## 3.2. Safety implications for in-vehicle distractions

### *3.2.1. Electronic and mobile devices use*

Drivers fail to see fifty per cent of visual information from the road environment when using electronic devices such as mobile phones and hands-free devices (British Columbia Ministry of Public Safety and Solicitor 2009). The use of electronic devices while driving is one of the largest sources of distraction due to the level of cognitive and visual distraction in terms of frequency and duration or time spent on these secondary activities. Sullman (2012) emphasise that with increasing access to technology in vehicles, it is essential to understand the prevalence of and type of distracted driving activities. Shinohara et al (2010) state that attention-demanding situations where switching between visual search and verbal tasks occur, task performance (driving safely) deteriorates.

Talking on a mobile phone *(using a hands-free set)* was observed 27 times during the two hours, constituting approximately 8% of the driving time. The conversations on average lasted approximately 45 seconds although the longest conversation was observed to last for more than 6 minutes. Cell phone conversations hamper performance but interaction with other electronic devices such as voice activate interfaces also influence performance negatively (Shinohara 2010). Drivers can talk or text without immediate consequences and the believe that one is risk-free takes form. An interesting notion put forward by British Columbia Ministry of Public Safety and Solicitor (2009) whom argues that the presence of Bluetooth$^{TM}$ and wireless technologies, built into vehicles, are creating the perception that interacting with these devices while driving is the norm rather than wrong.

Talking on the mobile phone *(holding the device in hand)* was observed 7 times constituting approximately 2.1 % of the driving time. The average length of a conversation was 1 and half minutes with the longest conversation approximately 10 minutes long. In South Africa talking on a handheld device while driving is illegal. A number of studies (real world as well as simulated studies) have highlighted the role that electronic equipment use play in near crashes as well as actual crashes. Research into the use of mobile phones and electronic devices started in the late 1960's. Redelmeier and Tibshirani (1997) correlated the cell phone usage of 699 drivers whom had been in crashes resulting in serious property damage but no personal injury by analysing cell phone records for the week preceding the crash as well as on the day of the crash. The findings, based on the analysis of 26 798 calls made during the fourteen month study, indicate that risk of crash increased by four times as opposed to not using a cellular phone when driving. (Redelmeier 1997). Negative effects on various driver performance measures include reaction and detection time, brake-reaction time and peripheral detection task as well as situational awareness (Shinohara 2010). In a simulated driving study, Strayer et al (2003) investigated the effect of conversation on hand held cell phones while driving (Strayer, Drews and Johnston, 2003). Indications were that the conversation negatively affected the drivers' ability to respond to braking vehicles in front of them and impaired memory about billboards and other information next to the road. Strayer et al (2003) concluded that conversing on a cell phone while driving resulted in a form of inattention blindness. In a simulator study, findings from 97 drivers indicate that female drivers perform worse in rural areas as they have the worst reaction times when conversing on a cell phone or with a passenger. In complex urban environments, the driver gets alerts from the environment, which assists the driver to self-regulate behaviour and compensate for decreases in attention. In rural areas, older drivers tend to decrease speed when driving distracted which again suggest that drivers compensate for their distracted behaviour (Papantoniou 2016).

Texting was not overtly observed in this study although the "looking down and reaching for objects in the vehicle" could potentially be indications of the driver reading texts or texting while driving. International research has established the risks associated with this behaviour. In the USA estimations are that teenagers on average send between 50 and 100 text messages a day (Llerena 2014). Approximately forty seven percent of driving adults and more than fifty per cent of driving teens admit to texting while driving. Texting and driving have been found to be detrimental to driving performance and Caird et al (2014) highlight that roughly one per cent of drivers in the United states of America (USA) are using a cell phone to text or phone at any given time (Caird, Johnston, Willness, Asbridge, and Steel, 2014). Texting while driving creates cognitive, visual, and physical distractions that interfere with perceptual as well as motor abilities needed to drive safely (Caird et al., 2014). Furthermore, Owens et al highlight that in 2011 crashes due to texting in the USA contribute to ten per cent of fatalities and seventeen percent of injuries. In a meta-analysis of available literature, Caird et al (2014) characterised the impact of reading and writing text messages on driving performance and traffic safety. The study considered findings from simulator, on-road as well as naturalistic driving studies. The study results show that texting while driving impairs all aspects of safety as a texting driver have prolonged glances away from the road, slower response times to hazardous situations in the road environment; are not able to adequately control their vehicles within a specific lane. Reading a text message seems to be the lesser evil with glances away from the road (at the cell phone to read the message) being shorter than glances away from the road to type or "typing-and-reading". In instances where a conversation tarts, the frequent and repeated glances away from the road limit the drivers' ability to detect hazards, limit reaction time to events, and impacts negatively on vehicle control. Owens, McLaughlin, and Sudweeks (2011) found that typing a simple message such as "on my way home" on average takes approximately 37 seconds, of which for 26 seconds the driver was looking away from the road, with the average amount of time looking at the phone being 17.5 times (Owens 2011). The longest glance away from the road was 2.7 seconds. Klauer et al (2006) have previously highlighted that glances longer than 2 seconds away from the road increase crash risk significantly (Klauer 2006). In addition, Caird et al (2014) state that texting drivers seem to compensate for their behaviour (redirecting their attention away from the road environment) by driving slower (reduction in speed), falling back, and increasing headway of lead vehicles. The authors argue that although this behaviour might be an intentional safety strategy, it can cause congestion and if following drivers are not able to anticipate the slower moving traffic, crashes occur.

*3.2.2. Passengers as a distraction*

Transporting passengers is a common occurrence. Passengers however do represent a form of distraction to the driver although the cognitive workload associated with this task seems to be less than when talking on a cell phone or hands-free kit (Shinohara 2010). Reasons include perceptions that the passenger sitting next to the driver can actually observe the traffic situation as well as modify the course and tempo of a conversation and advise the driver to take cautionary action if needed (Shinohara 2010).

Passenger distractions were observed 16 times (4.7 % of the driving time). Passengers were coded as a distraction if the driver looked away from the road to engage with the passenger.

Singh (2010) assessed distracted driving by analysing the National Motor Vehicle Crash Causation Survey (NMVCCS), which collects on-scene information regarding crash factors, including the ones related to driver inattention. Conversing with a passenger was the most prominent factor among non-driving activities that involved drivers' interaction with internal sources of distraction and was true irrespective of other factors such as age and gender, speed limit zone, weather, and traffic flow conditions in which the drivers were driving.

An Australian naturalistic driving study, following twelve families with children, found that children in a vehicle accounts for 12 % of distracting driving activities (Rudin-Brown 2012). The most prominent type of distracting activities were turning back to look at them or by viewing them through the rear-view mirror (76%), engaging in conversation with the children (16%), and assisting the children (8%) by for example, passing food and drink (Rudin-Brown 2012). The research also found that male drivers (fathers) distracted for much longer (on average 26 seconds) by children than their female counterparts (8 seconds).

*3.2.3 Safety implications of smoking and dining*

*"The act of taking a cigarette out of the packet, finding your lighter and coordinating your hand or hands to light the cigarette means you are likely to divert your gaze and your attention away from the road. Once you have lit it you then need to put your lighter and packet of cigarettes somewhere (Pizza et al., 2010)"*

Smoking behaviour which include reaching for, lighting and smoking a cigarette was coded 86 times constituting a quarter (25 %) of the total driving time. In Italy, evidence put forward by Pizza et al (2010) that smoking increase the risk of being in an accident by 3.2 times (Pizza 2010). A USA study found that smokers were 1.5 times more likely to be in a car crash (Hutchens 2008), while the National Highway Traffic Safety Administration (NHTSA) found that the process of smoking in a car increase crash risk by between 2-3 times (NHTSA, 2006). Any distractions like these reduce the drivers' ability to react to situations on the road. Mangiaracina and Palumbo (2007) video-recorded 10 people (4 male and 6 female) smoking while driving a car. Findings indicate that on average distraction of smokers is about 12 seconds. If a person drives at 50 km/h, a distance of 160 meters is covered. In comparison to cell phone distractions which on average last 10.6 seconds, a distance of 150 metres at 50 km/h is covered which indicate that smoking as a distraction, might be more dangerous that talking with a cell phone. (Mangiaracina 2007).

Dining while driving (eating and drinking) was coded 13 times constituting approximately 4 % of the driving time. A driving simulator study conducted by Yannis et al (2011) revealed that engaging in simple or complex conversations as well as talking, eating or smoking result in decreases in speed as drivers compensate for the distracting behaviour while driving. A pilot study on 2,919 vehicle crashes involving distracted drivers in Virginia showed that 6.3% of such crashes are attributable to eating, drinking, or smoking (Tuss 2011).

## 4. CONCLUSION

The intent of the project was to develop skills to working with the NDS methodology and NDD in general. This was accomplished although it is still clear that challenges pertaining to utilising resources for working with NDS along with the ability to process the large quantities of NDD persist. Coders need to familiarise themselves with the process and programmes and as was the case in this exercise, takes time to develop the skill and confidence to work with the datasets.

Information related to driving behaviour and its contribution to crashes and near-crashes in South Africa is limited. Apart from the research that has previously been conducted for the CSIR and RTMC project there are to our knowledge no local academic research that define or quantify inattentive and distracted driving behaviour at a microsecond level. These NDS projects therefore provide an opportunity to investigate specific driver behaviour at a level of detail which could in future, inform the development of new theories applicable to South African drivers.

## REFERENCES

Basacik, D and Stevens, A, 2008, '*Scoping Study of driver Distraction.* London: Department of Transport,.

British Columbia Ministry of Public Safety and Solicitor, 2009, '*Addressing the Problem of Distracted Driving and its Impacts to Road Safety Motor Vehicles',* General Office of the Superintendent of Motor Vehicles.

Direct observation, 2004, 1 April accessed on 8 November 2016 from http://www.kipbs.org/new_kipbs/fsi/files/directobservationtips.pdf.

Green, P.E. Wada, T., Oberholtzer, J., Green, P.A., Schweitzer, J and Eoh, H, 2007, '*How Do Distracted and Normal Driving differs: An analysis of ACAS naturalistic driving data.* University of Michigan Transportation Research Institute (UMTRI), Ann Arbor, Michigan

Huestegge, L., Skottke, E., Anders, S., Müsseler, J and Debus, G, 2010, 'The development of hazard perception: Dissociation of visual orientation and hazard processing', *Transportation Part F*, pp. 1-8.

Hutchens, L., Senserrick, T.M., Jamieson, P.E., Romer, D and Winston, F.K, 2008, 'Teen driver crash risk and associations with smoking and drowsy driving." *Accident Analysis and Prevention,* 40, pp. 869-875.

Klauer, S.G., Dingus, D.R., Neale, T.A., Sudweeks, J., Ramsey, D.J, 2006, '*The impact of driver inattention on near-crash/crash risk: an analysis using the 100-car Naturalistic Study data .* National Highway Traffic Administration, Washington D.C.

Kubina, R.M. and Lin, F.Y, 2014, 'Defining Frequency: A Natural Scientific Term', *The behavioural Analyst Today* , 9(1), pp. 125-129.

Llerena, L.E., Aronow, K.V., Macleod, J., Bard, M., Salzman, S., Greene, W., Haider, A., and Schupper, A, 2014, 'Distracted Driver: An Evidenced-Based Review', *Journal of Trauma, Acute Care and Surgery*, 78(1), pp. 147-152.

Mangiaracina, G and Palumbo, L, 2007, 'Smoking while driving and its consequences on road safety', *Annali Di Igiene: Medicina Preventiva E Di Comunita,* 19 (3), pp. 253-267.

Marshall, A, 2016, '*U.S. Drivers Are Distracted More Than Half the Time They're Behind the Wheel.* 8 March 2016', accessed on 17 november 2016 from http://www.citylab.com/commute/2016/03/major-distractions-for-drivers/472656.

Mayhew, D., Robertson, R., Brown, S and Vanlaar, W, 2003, 'Driver distraction and hands-free texting while driving." *Traffic Injury Research foundation*, April 2003, pp. 1-10.

Miller, S.G, 2016, '*Pokémon Go' Risks: Drivers and Pedestrians Warned on Traffic Dangers.* 16 September 2016, accessed on 17 November 17, 2016 from http://www.livescience.com/56132-pokemon-go-distracted-driving.html.

Owens, J.M., McLaughlin, S.B., Sudweeks, J, 2011, 'Driver performance while text messaging using handheld and in-vehicle systems', *Accident Analysis and Prevention*, 43, pp. 939-947.

Papantoniou, P., Yannis, G., Antoniou, C., Papadimitriou, E., Pavlou, D and Golias, J., 2016, 'Investigating the Effect of Area Type and Traffic Conditions on Distracted Driving Performance', *Transportation Research Procedia*, 14, pp. 3839-3848.

Rudin-Brown, C.M., Koppel, S., Clark, B and Charlton, J, 2012, 'Prevalence of mobile phone vs. child-related driver distraction in a sample of families with young children', *Journal of the Australasian College of Road Safety*, 23 (2), pp. 58-63.

Shinohara, K., Nakamura, T., Tatsuta,S and Iba, Y, 2010, 'Detailed analysis of distraction induced by in-vehicle verbal interactions on visual search performance', *IATSS Research*, 34, pp. 42-47.

Sullman, M., 2012, 'An Observational Study of Driver Distraction in England', *Transportation Research Part F: Traffic Psychology and Behaviour*, 15(3), pp. 272-278.

Venter, K, Labuschgne, F.J.J., Phasha, S., Gxowa, M., and Khoza, S, 2016, 'Indications of distraction and inattentative driving in South Africa', *Southern African Transport Conference,* Pretoria, pp. 1-10.