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Behavioural Predictors of Driver Crash Risks in Ghana

By:

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Dedication

I dedicate this work to my wife; Mavis Bansah, my daughters; Cindy Afeafa and Celinda Selikem Dotse, my mother; Emilia Ama Addae, my elder sister; Stella Bonney. I also dedicate this work to the memory of my late father; Richard Yao Bonifacio Dotse, my late uncle; K. K. Addae and all victims of road crashes in the Global South.

Acknowledgments

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Abstract

There is a growing body of literature on driver crash risks in the developed world, but little is known about how well these models apply to motoring in the Global South where the burden of road crashes is greatest. Three studies were conducted to address the behavioural predictors of driver crash risks in Ghana. In Study 1 (Chapter 2), a qualitative approach was taken to explore factors influencing crash risks for commercial passenger drivers in Ghana. Some crash risks that are shared with drivers in the developed world such as fatigued driving and speeding were identified in Ghana too, but their presentation was moderated by the Ghanaian context. Other identified factors such as aggressive competition over passengers and corruption are rarely considered in research addressing driving behaviour in developed countries. Study 2 (Chapter 3) modelled road crash risk for Ghana using the Manchester Driver Behaviour Questionnaire (DBQ). Exploratory and confirmatory factor analyses produced a 24 item 2-factor (violations and errors) model of the DBQ. As evidence of the external validity, both violations and errors were independently correlated with crash involvement and sensation seeking. While the Ghanaian DBQ shows a different factor structure from other research conducted in the developed world, the findings support the usefulness of the measure in characterizing the behaviours underlying crash risk in Ghana.

Study 3 (Chapter 4) quantitatively modelled the processes underlying risky driving behaviours for Ghanaian motorists and compared them to a sample of UK drivers. Analysis was guided by a modified version of the Contextual Mediated Model (Sumer, 2003) which proposed a set of distal effects (e.g., personality) on crash involvement that are partially mediated via proximal driving behaviours. Structural Equation Modelling showed that distal factors predicted crash involvement both directly and indirectly through proximal behavioural risks (violations, errors

and hazard monitoring) in both Ghana and the UK. The findings from the three studies have implications for road crash prevention policy and intervention design in the Global South.

Publications and presentations arising from this thesis

Publications

Dotse, J. E., Rowe, R. & Nicolson, R. (2018)* Behavioral influences on driver crash risks in Ghana: A qualitative study of commercial passenger drivers. *Traffic Injury Prevention, 20(2), 1-6. doi: 10.1080/15389588.2018.1556792*

Dotse, J. E. & Rowe, R. (revision invited) ** Modelling Ghanaian road crash risk using the Manchester Driver Behaviour Questionnaire. *Safety Science.*

* Chapter 2 includes edited sections of the above paper.
** Chapter 3 includes edited sections of the above manuscript.

Presentations

Dotse, J. E., Rowe, R., Blades, M., & Nicolson, R. (2018, July). Behavioural predictors' driver crash risks in Ghana. Paper presented at the Annual Conference of the British Society for the Psychology of Individual Differences (BSPID), Edinburgh, United Kingdom.

Dotse, J. E. (2017, June). Validation of the Driver Behaviour Questionnaire in Ghana. Paper presented at the WRDTC/P 6th Annual Conference, Sheffield, United Kingdom.

Dotse, J. E. (2017, June). Identifying factors to reduce road crash fatalities in Africa: The case of Ghana. Paper presented at all African Post-graduate Research Group Conference (AAPoRG): (Africa in the Era of Sustainable Development Goals), Sheffield, United Kingdom.

Dotse, J. E. (2017, May). Identifying Behavioural Targets to reducing Road Crash Fatalities in Ghana. A Qualitative Enquiry. Paper presented at the British Psychological Society Annual Conference, Brighton. United Kingdom.

Dotse, J. E., Rowe, R. & Nicolson, R. (2016, September). Commercial driver crash risks in Ghana: A qualitative study. Paper presented at the Autum White Rose Postgraduate Research Conference. School of Psychology, Faculty of Medicine and Health, University of Leeds, United Kingdom.

Dotse, J. E., Rowe, R. & Nicolson, R. (2016, September). Factors influencing crash risks for commercial drivers in Ghana: The environment or the behaviour? Paper presented at the British Environmental Psychology Society (BrEPS) Conference, Environmental Psychology Research Centre (EPRC), University of Surrey; Guildford, United Kingdom.

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Chapter 1: Introduction

Research evidence on factors influencing road crashes worldwide suggests that driver-related behavioural factors contribute strongly to causation. For example, Petridou and Moustaki (2000) estimated the behavioural contribution as 95% while factors such as road conditions account for the remaining 5%. Behavioural factors have not been given adequate attention in both research and policy, especially in developing parts of the world that are most affected by this public health challenge (Largarde, 2007). To support road safety improvement, it is necessary to identify the behavioural factors responsible for road crashes and the extent to which these factors predict driver crash risks in such settings. This thesis addresses the road traffic situation in Ghana where road traffic crash causes a substantial and increasing public health burden (National Road Safety Commission [NRSC], 2015).

In this chapter, an overview of the global burden of road traffic crashes as well as that of Ghana is provided. A review of Ghana's road safety policies in relation to international policies and conventions on road safety is presented followed by consideration of the literature focusing on psychosocial, cognitive, personality related, mechanical and environmental determinants of road crashes, most of which was conducted in the Western world. The review is organised around the Contextual Mediated Model of the behavioural factors underlying road crash (Sumer, 2003) based on Western literature. The limitations of the existing research base addressing predictors of road crash in countries in the Global South (low and middle income countries), such as Ghana, where road traffic crashes are particularly frequent, were assessed in the review. Global South countries have medium-low (< .70) human development index; Africa, 54; Ghana, .59; Kenya, 59; Nigeria, .53; and Niger .35 (United Nations Development Programme [UNDP's] Human Development Report, 2019). The revision and application of the Contextual Mediated Model to driving in low-middle income countries was also discussed.

1.1 The global burden of road crashes

Road crashes claim over 1.35 million lives globally every year with about 50 million more sustaining severe injuries (World Health Organisation, WHO, 2018). Road crash involves a collision of a moving vehicle on a public road resulting in injury to a road user (human or animal) or damage to property (The International Traffic Safety Data and Analysis Group [IRTAD], 1992). With a daily average of 25,000 deaths, road traffic injuries are currently the eighth leading cause of death across all age groups, and the leading cause of death among children and young adults aged 15-29 (WHO, 2018). Road crash injury is predicted to become the third leading cause of death across all age groups by 2020 and the second by 2030 if unchecked (Peden et al., 2001; WHO, 2015). Road traffic injuries cause 3% of GDP lost to developed economies, and 5% in the Global South (Peden, 2005). Road traffic fatalities impose a huge burden on national health and insurance systems. This applies mostly to national economies that have other developmental needs and where investment in road traffic safety is not commensurate with the magnitude of the challenge (Mock, Kobusingye, Anh, Afukaar, & Arreola-Risa, 2014; WHO, 2015). In the Global South the economically active age groups (15-59) are the worst affected thereby increasing the poverty levels of families (The Economist, 2015; WHO, 2015).

1.2 Ghana's road transport and traffic safety situation

1.2.1 The nature of the road transport system of Ghana

There are estimated 1.6 million registered vehicles on Ghanaian roads of which about 85% are commercial (passenger and goods vehicle) and 15% are private (Driver and Vehicle Licensing Authority of Ghana [DVLAG], 2017). The private vehicles are mostly saloon and cross-country vehicles used by individuals and families (see Figure 1.1 below). Public transport services are provided by minibuses locally called 'trotro' (see Figure 1.3), big buses (coaches) (see Figure

1.2) and shared taxis (see Figure 1.4) with each having prescribed passenger capacities (Road Traffic Act 683 of 2004). The minibuses have capacities of between 12 and 30 passengers; the big buses can have up to 60 passengers and taxis can take only up to four passengers. But it is common to see these capacities being breached, for example shared taxis taking up to 6 passengers (Ackaah & Adonteng, 2011). The minibuses and taxis are usually used for short distance journeys while the big buses are used for long journeys (inter-regional travels). Private ownership accounts for between 85 and 90% of Ghana's public transport facilities, while the state contributes approximately 10% (Abane, 2011). The daily operations of public transport are therefore mainly regulated by bodies set up by the private transport owners (e.g., Ghana Private Road Transport Union [GPRTU]) and as such, they have become the trainers and employers of the majority of the commercial drivers in Ghana.

Drivers' remuneration is often fixed on a commission basis; a system locally referred to as 'work and pay'. This system requires the driver to hire the vehicle from private owners for an agreed amount on a daily basis depending on the capacity and condition of the vehicle hired. There are designated lorry terminals/stations in every city and town where many of the commercial passenger vehicles pick-up and discharge passengers. Other commercial vehicles, most often the "*trotro",* have neither a designated route nor a plan of movement. They operate on any route depending on the availability of passengers. Unlike the situation at the designated lorry terminals, the passenger loading activities of the '*trotro'* buses are not always regulated. Usually, commercial drivers, except for taxis, work with 'mates' (assistants who serve as conductors and fare collectors on the bus). A 'mate' becomes a full driver after undergoing an apprenticeship for a mandatory minimum period of three years while serving as a fare collector and conductor. However, the absence of a formal prescriptive law within the road traffic act (Act 683 of 2004) may make the monitoring and enforcement of their training impossible.

Ghana has comprehensive driving laws; Ghana Road Traffic Regulations, 2012 (L.I 2180) made under Section 133 of the Ghana Road Traffic Act, 2004 (Act 683). The act guides the operation of any form of motor vehicle on Ghana's roads and covers such areas as registration of vehicles, driver testing and licensing, drink driving, the use of seatbelts (e.g., Regulation 119; *A person shall not drive a motor vehicle unless the motor vehicle is fitted with a seat belt*) and helmets, highway codes, traffic law enforcement and punishment among others. The Motor Traffic and Transport Department of the Ghana Police Service (MTTD) are mandated to enforce the driving laws in Ghana. Traffic police are occasionally dispatched onto some major roads within the cities while police checkpoints are erected along all highways in the country. Driver licensing in Ghana is a two stage process; 1) Physical examination and eye test and 2) on road practical test. Applicants trained in formal driving schools are required to take a theory test (written examination; computer based test) before practical driving test.

Figure 1.1 A private car on the road in Ghana

Figure 1.2 A metro bus in Ghana

Figure 1.3 A minibus (‘Trotro’) used for public transportation in Ghana

Figure 1.4 Shared taxis at a lorry terminal in Ghana

Figure 1.5 A view of a passenger lorry terminal/station in Ghana

1.2.2 The burden of road crashes in Ghana

Means of transportation in Ghana's is 95% road, while air, water and rail transports account for the remaining 5% (The Report: Ghana, 2016). The road transport sector remains the most hazardous among all modes of transportation (WHO, 2015). The high number of Ghana's road crashes exemplifies the contribution of road crashes to mortality and morbidity in Africa. With an estimated population of 28 million, an average of six people die daily through road crashes in Ghana (Coleman, 2014) which is 29.6% of total deaths in the country (WHO, 2014). The death rate from road crashes has increased by 83.6% between 1991 and 2011 (Hesse & Offosu, 2014), and has grown by between 12 and 15% every year since 2008 (NRSC, 2016). There was a corresponding increase in the number of registered vehicles of 146% between 1991 and 2015 while the national population grew by 81.1% during the same period (NRSC, 2016).

In 2017, a total of 2,076 people died through road crashes in Ghana that involved 20, 444 vehicles while an additional 12,166 individuals sustained severe injuries (Motor Traffic and Transport Unit of the Ghana Police Service (MTTU), 2018; NRSC, 2018). Passengers of commercial vehicles (vehicles that offer public transport services and goods transportation) and pedestrians formed the majority (77%) of the casualties with 42% being passengers and 35% being pedestrians (NRSC, 2017). Approximately 95% of all motor vehicle-related injuries in children and 79% in adults in Ghana involve commercial vehicles (Mock, Amegashie & Darteh, 1999). Although the continued rise in motorisation in Ghana can partly explain the increase in the crash rates, many Western countries have had great success in reducing the incidence of road traffic injuries in recent decades (Ameratunga, Hijar, & Norton, 2006).

1.2.3 International and local policies on road safety

In response to the growing global ‘epidemic' of road crash-related deaths, the UN General Assembly in 2010 adopted Resolution 64/255 to establish a decade of Action for Road Safety (2011-2020). The policy has been most successful regarding enforcing seat-belt laws. One hundred and five countries (67% of the world’s population) have laws that meet best practice criteria (WHO, 2015). As part of the UN action plan, information on road safety measures including legislation and road user behaviour among all member countries is to be collected. The WHO reports (2013; 2014; 2015) have however noted the poor quality and inaccuracy of road traffic crash reporting data and the crash prevention measures in many African countries including Ghana.

In response to the UN General Assembly’s resolutions, as well as other conventions (e.g., Sustainable Development Goals [SDG-3]) Ghana’s road transport sector has seen some reforms through the activities of key state institutions. These institutions include the National Road Safety Commission (NRSC) established by an Act of Parliament (Act 567 of 1999) and the Motto Traffic Unit (MTTU) of the Ghana Police Service. These agencies are mandated to formulate and implement policies, enforce laws, coordinate, regulate, monitor and review programmes and activities including the promotion of safety in the road transport sector.

1.3 Global road crash fatality trends

Although road crash fatalities are a global public health challenge, there are many continental and regional differences in the contributory factors and the rates of occurrence (Nordfjaern, Simsekoglu, & Rudmo, 2014). The global yearly average of road crash-related deaths per 100,000 population is 18.2 however, there is inter-continental variation; Europe; 9.3, Asia; 18.2, and the Americas; 15.6 and 26.6 in Africa (WHO, 2018). Road crash incidents are highest

in the Global South which accounts for 90% of the global deaths from road traffic injury (WHO, 2015). As observed in the history of Western civilisations, motorisation brings an initial increase in road traffic fatalities which peaks and then starts to decrease. This trend was identified in the US and the Netherlands, for example, where road traffic fatalities increased steeply to a peak (around 1972) and have declined steadily to 2011 (41% in the US and 81% in the Netherlands) (Evans, 2014). African countries have motorised later than the Western world so they have not yet reached their peak. Consequently, road crashes are predicted to decrease in developed countries by 2020 but are estimated to increase significantly in the Global South in the same period (WHO, 2014). A prudent scientific national road safety policy was identified as an important contributing factor to the time trend reduction in the fatalities in the developed world (Evans, 2014). There is a need to understand driving behaviour to inform road safety policy and intervention in Ghana.

1.4 What are the behavioural factors underlying crash risks?

Behavioural factors represent an individual's actions that are either covert or overtly exhibited in response to stimuli (Bandura, 1983). Behavioural factors in the context of driving include risky behaviours such as speeding, drink driving, distracted driving, fatigue and sleepy driving. Underlying these risk-taking behaviours are beliefs and attitudes such as risk perception (Rowe et al., 2016). Risk perception is a cognitive probability estimate of accidents (crash involvement) and the perceived potential severity of the consequences for the individual (Sjöberg, 1999). There are also trait and personality factors such as anxiety, impulsivity, aggression and neuroticism that underlie the behavioural factors (Daciu, Popa, Micle, & Preda, 2012; Simons-Morton et al, 2012). Cognitive factors are also important; safe driving requires mastery of perceptual-motor car control skills and proficiency in situation awareness (Endsley, 1995) that supports understanding the current driving environment and predicting future states.

Deficiency here can result in the inability to effectively perceive developing hazards (Aksan, Anderson, Dawson, Uc, & Rizzo, 2015). Additionally, socio-demographic factors including age, gender and level of experience that affect driver crashes through driving skills and risk-taking are equally prominent in the road crash literature (Krahe & Fenske, 2002; Miles & Johnson 2003; Shen & Neyens, 2015). However, most of the research is based on findings from the developed world and its applicability to low and middle-income countries contexts is largely untested.

Risky driving behaviours are often categorised as violations or errors (Reason, Manstead, Stradling, Baxter, & Campbell, 1990). Violations are acts that contravene norms and the general code of conduct prevailing in a given society. Traffic violations involve flouting traffic rules or non-adherence to road user guidelines which are common knowledge among all road users. Reason et al. (1990: 1316) defined the behaviour as; "*deliberate deviations from those practices believed necessary to maintain the safe operation of a potentially hazardous system*". Although traffic regulations differ among countries, there are some common behaviours identified as constituting violations in many settings. Behaviours such as speeding and jumping traffic light signals, chasing another driver to express annoyance, and sounding a horn to indicate anger are usually described as violations (Lajunen, Parker, & Summala, 2004; Lawton, Parker, Manstead, & Stradling, 1997).

Errors can be formally described as; *'*a generic term to encompass all those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcome, and when these failures cannot be attributed to the intervention of some chance agency' (Reason et al., 1990: 9). Driving errors arise from cognitive processing failures and may occur from inexperience or inattention (af Wåhlberg, Dorn, & Kline, 2011). They are judgments and

decisions that turn out to be faulty and can pose a hazard to the driver and to other road users (Lajunen & Summala, 2003). Errors are involuntary producing unwanted results and their occurrence has been linked to several factors (e.g., driver distraction) (Staubach, 2009). Based on a classification by Norman (1981) driving errors often take such forms as an erroneous classification of a situation, and incomplete or unclear specification of intention. Errors in driving just as violations have been identified as a major contributory factor to all road crash globally (Hankey et al., 1999; Rumar, 1990). Driving errors and violations are often measured using the Driver Behaviour Questionnaire (DBQ) (eg., Lajunen, et al., 2004; Parker, Reason, Manstead, & Stradling, 1995; Reason et al., 1990).

In the DBQ, violations may be additionally subdivided into ordinary and aggressive violations whereas errors may be subdivided into errors and lapses/slips (Lajunen, et al., 2004; Parker et al., 1995). Aggressive violations reflect interpersonally aggressive traits such as anger. Ordinary violations involve deliberate engagement in behaviours that deviate from safe driving devoid of specific aggressive intent (e.g., disregard speed limits) (Lawton et al., 1997). Lapses were defined as memory failures likely to cause embarrassment that could be distinguished from more serious forms of error. A lapse may take such forms as misperception, action intrusion, an omission of action, reversal of action and mistiming of action (Reason, 1990). A number of studies indicate that lapses are correlated with crash involvement (af Wåhlberg, Dorn, & Kline, 2011). However, the most important behavioural distinction made in the DBQ is between broadly defined violations and errors (de Winter & Dodou, 2010).

Although engagement in violations and errors may not automatically result in a crash they tend to increase the risk of crash involvement (de Winter & Dodou, 2010; Reason et al., 1990). The links between violations, errors and crash involvement were illustrated through a meta-analytic

review (de Winter & Dodou, 2010) on the predictive effect of the dimensions of the DBQ on self-reported crashes. A total of 174 studies were identified with violations tested in 42 samples and errors in 32 samples. Both violations and errors had significant positive relationships with crashes. The violation factor predicted self-reported crashes with an overall correlation of .13 while the error factor produced a coefficient of .10. In updated meta-analytic review violations and errors correlated moderately with self-reported crash involvement; the updated correlations were estimated for violations; r = .13 (based on 67 samples) and Errors; r =.09 (based on 56 samples) (de Winter, Dodou, & Stanton, 2015).

Further evidence for the validity of the DBQ is provided by data showing the measured scales correlate with other measures of driving behaviour. In a driver simulator study, violations and speeding significantly predicted self-reported on-road violations (de Winter, 2013). DBQ violations were associated with objectively measured speed on an instrumented vehicle and a simulation study, r=.38 under both conditions (Helman & Reed, 2015). Different dimensions of driving behaviour have different demographic correlates. For example, more errors were observed for elderly drivers while violations such as speeding were more common for young drivers and for males rather than females (Parker et al., 1995; Reason et al., 1990). Violations may reflect a habitual style of driving while errors represent performance limits of the driver (de Winter & Dodou, 2010). Despite the attempt to distinguish between violations and errors, Reason et al. (1990; 1381) asserted that 'the conceptual boundaries between violations and errors are by no means hard and fast' as it is possible to err without committing a violation and similarly one may commit a violation without erring. There exist correlations; .3 - .7 between errors and violations (Conor & Lai, 2005; Freeman et al., 2009; Özkan & Lajunen, 2005a; Sumer, Ayvasik, & Er, 2005).

Rowe, Roman, McKenna, Barker, and Poulter (2015) modelled a general factor of aberrant driving from DBQ data with additional specific error and violation factors in a bifactor framework. The results showed that specific factors for ordinary and aggressive violations, slips and errors were clarified as having independent predictive effects from the general factor in crash prediction (Rowe et al., 2015). The key conclusion drawn by Rowe et al. (2015) was that a common aberrant driving factor contributes to responding to both errors and violations, and the common factor is itself related to crash involvement.

1.5 Cultural differences in the applicability of road crash prediction models

Models of road traffic crash risk in developed countries have been presented in the academic literature. These have included the application of the Theory of Planned Behaviour to driving (e.g., Parker et al., 1995), the application of personality models (Sumer, Lajunen, & Ozkan, 2005) and The Contextual Mediated Model (Sumer, 2003 [see Section 1.7.1]). These models have not been adapted to low and middle-income countries (Staton et al., 2016). It cannot be assumed that models based on data from the Western world will apply to developing countries, given cultural variations in the context of driving (Coleman, 2014; Mohan, 2002). Local driving environment and culture may influence the relationships between specific factors and driver crash risks (Nordfjaern et al., 2014). For instance, a study on the applicability of the various dimension of the DBQ among a matched sample from six European countries revealed some major variations among drivers from Northern-Western European countries and those of Southern and Middle Eastern Europe (Ozkan, Lajunen, Chliaoutakis, Parker, & Summala, 2006). This evidence does not support the application of Western models to the Global South.

The fit of the three-factor model of the DBQ was partially satisfactory in each of the countries (Finland, Great Britain, Greece, Iran, The Netherlands, and Turkey). Specifically, the ordinary

violation and error factors were both congruent across the countries. The aggressive violation factor was however inconsistent across the countries but applicable in each country. Differences were found in the absolute level of the DBQ behaviours across culture; there were more ordinary violations recorded for Northern-Western European countries while aggressive violations and higher crash rates were more prevalent among Southern and Middle Eastern European groups (Ozkan et al., 2006). Style of driving was found to mediate between road traffic culture of a particular country and rate of crashes. The extent to which DBQ factors predicted crash involvement varied among the countries. For instance, a significant relationship was found between aggressive violations and number of crashes in Finland and Iran, but not for other countries while errors related significantly to crashes in Turkey but not in the other countries (Ozkan et al., 2006). Given the relatively weak relationships between DBQ and crashes observed by Ozkan et al., sampling variation in the estimate of the DBQ-crashes relationship other than cultural differences may be a plausible alternative explanation for the pattern of results found. The evidence nonetheless suggests that some, but not all aspects of models of driving behaviour based on data from developed countries may generalise to low and middle income countries.

Nordfjaern et al. (2014) investigated cultural differences in attitude towards road safety related to traffic regulations and their practices in a sample of countries across the world. Substantial variations were observed in road traffic safety cultures among pedestrians in Norway, Russia, India, Tanzania, Ghana, Uganda, Turkey and Iran. Participants from Sub-Saharan Africa reported relatively high crash risk perceptions measured using self-report (Perceived risk in road traffic scale; Rundmo & Fuglem, 2000). Social cognitive risk constructs; risk perception and attitude explain major portions of variance in Norwegian-Russian and Indian cultural clusters but not for other clusters (Nordfjaern et al., 2014). Similar to the previous study

reviewed above this evidence adduced by Nordfjaern et al. demonstrates the need to empirically test whether Western models of driving behaviour may be applied to low and middle income countries.

1.6 Predictors of driver crash risks and crash involvement in the Western world

1.6.1 Contextual mediated model of road crashes (Sumer, 2003)

One model that has attempted to explain the links between a number of behavioural factors, crash risks and crash involvement is the contextual mediated model (Sumer, 2003) which is illustrated in Figure 1.6. This model distinguishes between distal factors and proximal factors that affect crash involvement. The proximal factors are both stable (e.g., violations and errors) and transitory variables (e.g., drunk driving) that are closer to crash involvement and directly increase the risk of crashes. The distal factors (e.g., safety attitudes and personality) are those that create the tendency to engage in risky driving behaviours that in turn predict actual crash involvement. The proximal factors have direct effects on crash involvement while the distal factors may have both direct effects and also indirect effects that are mediated by the proximal factors. Sumer (2003) found that personality factors, for instance, had an impact on road crashes through their effects on actual driving-related behaviour. Sumer (2003) found that stronger relationships exist between distal and proximal factors than between proximal factors and crash involvement. There are other plausible models (e.g., a more parsimonious theory; The Theory of Planned Behaviour [Adjen, 1991]) that were proven to be effective in predicting behaviour (Armitage & Conner, 2001; Poulter, Chapman, Bibby, Clarke, & Crundall, 2008), but the contextual mediated model provides a wider behavioural domain that may be much suitable for the present study considering its exploratory nature and the context. The contextual mediated model was tested among professional drivers (Sumer, 2003) that form part of the present sample. In the next sections, the evidence supporting the identified factors and their role

in crash causation, as specified in the Contextual Mediation Model in the developed world, and the applicability of the evidence to developing countries will be discussed.

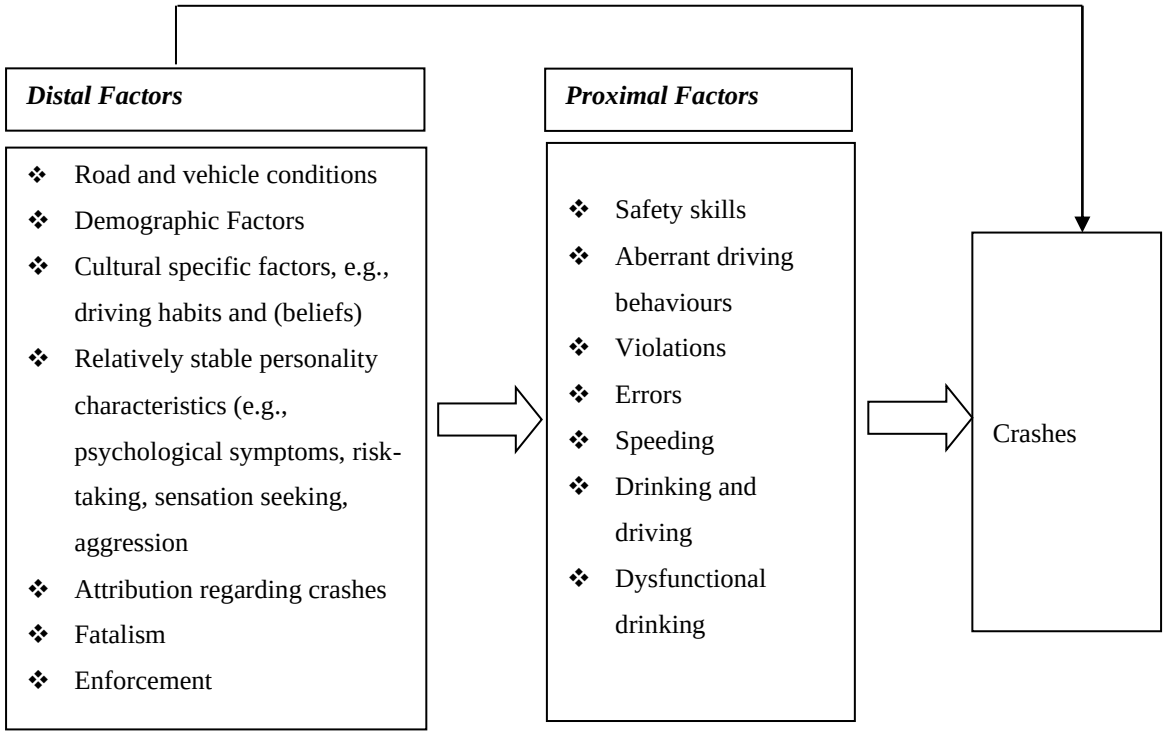

Fig 1.6 The Contextual Mediated Model of road crashes (Sumer, 2003*)*

1.6.2 Safety skills in crash involvement

Hazard perception is one of the best documented safety skills relevant to crash prevention. Hazard perception is mental representation and assimilation of the probability that there is a potential for road crash early in an evolving driving scenario (Horswill & McKenna., 2004). Hazard perception is typically measured through simulations (Pelz & Krupat, 1974; Underwood, Crundal, Chapman, 2011; McKenna & Crick, 1994) that are based reaction time measures to the onset of driving hazards or on prediction of what will happen next in a paused driving scenario (Crundal, 2016). Hazard perception has been associated with crash risk by a number of researchers. Computer-based hazard perception test scores for drivers were associated with crash involvement, both retrospectively (Boufous, Ivers, Senserrick, &

Stevenson, 2011; Horswill & Mckenna, 2004; Horswill, Anstey, Hatherly, & Wood, 2010) and prospectively (Congdon, 1999). Evidence also indicates that level of hazard perception is influenced by a range of well documented correlates of crash risk, such as driver experience (Borowsky, Shinar, & Oron-Gilad, 2010; Horswill et al., 2008; Scialfa et al., 2011, 2012; Wetton, Hill, & Horswill, 2011), driving under fatigue (Hamid, Samuel, Borowsky, & Fisher, 2014), drinking (Deery & Love, 1996), and distraction (Borowsky et al., 2014, 2015; Horswill & McKenna, 1999; Savage, Potter, & Tatler, 2013; Taylor et al., 2013). The introduction of hazard perception testing and training has reduced crash involvement for new drivers (Wells, Tong, Grayson, & Jones, 2008).

Some researchers (e.g., Matthews, Desmond, Joyner, Carcary, & Gilliland, 1997) have measured the related concept as hazard monitoring through self-reports. Using self-report measures, hazard monitoring has been related to dimensions of the DBQ; violations, major and minor errors and speed (Matthews et al., 1997). Based on this evidence and the role of safety skills specified in the contextual mediated model (Sumer, 2003) hazard monitoring is likely to relate directly to crash involvement and is considered a proximal factor in the present study.

Regarding other aspects of the proximal factors in the Contextual Mediated Model; errors have already been discussed as another measure of safety skills while the coverage of violations in the later sections of this chapter can be linked to the violations specified in Sumer's model. Collectively both the errors and violations constitute aberrant driving as specified by the model (Panayiotou, 2015). In Sumer's model drink driving and dysfunctional drinking were treated as proximal elements due to the sole significant impact of alcohol (about 47%) on road crash fatalities (Evans, 1991). There is evidence that drinking habits were stable determinants of drunk driving (Aber, 1993 cited in Sumer, 2003), therefore dysfunctional drinking that may

lead to drink-driving were considered as proximal to crashes. In the present study drink-driving is hypothesised to be another indicator of violations.

1.6.3 Evidence relating to the distal factors specified in the contextual mediated model

1.6.3.1 Road and vehicle conditions as predictors of driver crash risks

Road and vehicle conditions that contribute to crash involvement include adverse weather conditions, and structural and engineering challenges (Dorn & Machin, 2004). The United States Federal Motor Carrier Safety Administration [FMCSA] (2006), reported that at least 2% of road crashes in the USA are related to environmental factors while 10% are due to vehicle-related factors. Environmental factors have a direct impact on driver crash risks. For example, aggressive driving (Shinar & Copton, 2004), anger and rage (Nebit, Conger, & Conger, 2007) may be a reaction to environmental factors such as traffic congestion. These reactions may be triggers for the manifestation of an unsafe approach to driving. Shinar and Compton (2004) found that frustrations resulting from traffic congestion correlated positively with violations (tailgating, weaving in and out of traffic, and improper lane changes, as well as obstructing other cars from passing).

The physical condition of a vehicle is an important factor that can contribute to crashes (Af-Wahlberg, 2004). Roadworthiness of vehicles is regulated by enforcement of the law in the West but there is much more variation in enforcement approaches in the developing world (Nantulya & Reich, 2002). To reduce the likelihood of truck crashes in the developed world, drivers are required to inspect their vehicles for any mechanical defects prior to making a trip. The FMCSA estimated that about 10% of all crashes in the US involve vehicle defects as the crucial pre-crash causal factor and thus underscores the importance of driver inspection (FMCSA, 2006). The FMCSA's study suggests that the most common vehicle problem

involved defective brakes. These insights are consistent with Corsi, Farana, and Roberts (1984) and Corsi, Farana, and Jarrel (1988) who found that the crash rates for older trailers and defective vehicles were higher. Additionally, Corsi et al. (1988) found evidence that vehicles with higher frequency of per vehicle-mileage had more crashes. Therefore, it is more likely that drivers with a higher rate of vehicle breakdown will have a greater likelihood of future crash involvement. An important behavioural factor that emerges in relation to the vehicle safety maintenance argument is adherence to safety culture. Safety culture formalities have become key considerations in many 21st century organizations especially with jobs that are hazardous (Hofmann, Burke, & Zohar, 2017). But this construct has received limited attention in the driving behaviour and crash prevention literature.

In Asia road crashes have been linked to the following four factors, in isolation or in combination: equipment failure, road design, drivers' behaviour and poor road maintenance (Feng, Lia, Cia, & Zhang, 2016). However, Mallia, Lazuras, Violani, and Lucidi (2015) suggested that over 95% of all road crashes were attributable to the behaviour of the driver and the combination of one or more of the other three factors (road design and maintenance, and equipment failure). It is important to note from the above pieces of evidence that there are behavioural factors lurking behind the mechanical related factors as humans are responsible for maintaining their vehicles.

1.6.3.2 Demographic predictors of crash risk

1.6.3.2.1 Age and sex

Demographic variables, most importantly age and sex have been associated with driver crash risks and crash involvement (de Winter & Dodou, 2010; Evans 2000). Globally young drivers are over-represented in road crashes (van Leeuwen, Happee, & de Winter, 2016) and more than

1000 young people under the age of 25 years are killed in road traffic crashes around the world each day (WHO, 2015). Even with a comparable level of experience to the elderly, young age is still associated with greater crash risk (McCartt, Mayhew, Braitman, Ferguson, & Simpson, 2009). Crash involvement declines steeply with age, from over 20% for late teens through to early twenties, to under 1% for age 65 (Evans, 2000). Violations (e.g., speeding) that are attributed to higher levels of sensation seeking (Jonah, 1997; Mallia et al., 2015), drunk driving, and non-use of seat-belt (WHO, 2015) contribute to the over-involvement of young drivers.

Inexperience (Mayhew, 2007) that lead to errors was also identified to predict young people's crash involvement. Executive functions such as reasoning, decision making and inhibition are not fully developed in the young adults below approximately 25 years (Paus, 2005) and these may impair driving performance. The probability of crashing is highest for drivers with low experience (novice), thus increased length of licensure had a significant protective effect on crash risk after controlling for exposure (McCartt et al., 2009). However, traffic violations increase with increasing driving experience (Roman et al., 2015; Wells et al., 2008a, 2008b). The increase in experience that comes with driving skill improvement leads to a reduction in errors that later becomes stable (de Winter, Wieringa, Kuipers, Mulder, & Mulder, 2007).

Fisher, Pollatsek, & Pradhan (2006) found that poor hazard perception and anticipation abilities are partly responsible for the high collision traffic crash rate of novice drivers. Ren, Jin, and Kang (2007) observed that novice drivers often pay attention to and process large amounts of information while driving which could possibly lead to errors. However, experienced drivers (10 years and above in driving) were found to be more overestimate their abilities (Li, Liu, Yuan, & Liu, 2010) that may result in errors. McCartt et al. (2009) showed that age and

experience independently predicted violations and crash involvement after differences in driving mileage were controlled. The fundamental conclusion here is that age and experience have independent effects on crash risk. The independent effect of age is most likely to reflect a reduction in risk-taking whereas the independent effect of experience is likely to reflect skill improvement and therefore error reduction.

Older drivers may be at greater risk of crash involvement due to ageing reducing their driving skills. However, reduction in mileage for the older drivers compensates for the cognitive problems thereby reducing their absolute crash risks (Evans, 2000). Epidemiological studies (Evans, 2000; Lyman et al., 2002 cited in Aksan et al, 2015) project an increase of 178% of crashes among elderly drivers (65 years and above) by 2030. This has been attributed partly to executive function challenges among elderly drivers (Aksan et al., 2015). Daigneault, Jolly, and Frigon, (2002) found among elderly drivers with history of crash involvement compared to a control group that they (1) recorded lower scores on four cognitive measurements of executive functions (2) report behaviours that are more prudent on the road (e.g., not speeding) and (3) have the intention drive more safely (less risky driving behaviour). The Daigneault et al. study suggests that a subgroup of driver population may have driving disabilities and cognitive challenges that cannot be compensated for by the adoption of a more careful behaviour on the road and as such may be more prone to errors. However, aggressive violations (e.g., sounding of the horn to indicate annoyance) (Chliaoutakis et al., 2002) and road rage that increases the risk of crashes (Deffenbacher, Deffenbacher, Lynch, & Richards, 2003) are less likely to occur among elderly drivers.

Age effects on crash risks are not independent of sex differences. Researchers found that from young age (below 20) road traffic crash involvement for males is more likely to be higher than

for females, while those under the age of 25 years are about three times as likely to be killed as their female counterparts (e.g., Evans, 2000; Feng et al., 2016). This may reflect higher exposure; males are more likely to often be on the road due to socio-cultural reasons (WHO, 2015) as well as a greater propensity to take risks, compared to females (Cordellieri et al., 2016). The evidence suggests that males report more violations while females report more errors (e.g., de Winter & Dodou, 2010, 2016; Lajunen, Parker, & Stradling, 1998; Maxwell, Grant, & Lipkin, 2005; Reason et al., 1990). In a large cohort study, males and younger drivers were more likely to engage in aberrant driving behaviours (Roman et al., 2015). The New South Wales Risk Management Research Center of Australia has found that many young drivers are more likely to disregard their fatigue conditions and drive, and are more likely to exceed speed limits under such conditions (Hatfield, Murphy, Kasparian, & Job, 2005). The evidence regarding age and sex effects on crash risks and crash involvement is consistent with Sumer's (2003) Contextual Mediated Model. Due to higher levels of exposure it is expected that age and sex will be independent of errors and violations in predicting crash involvement.

1.6.3.3 Personality factors and driving outcomes

Some researchers have indicated that there are only weak associations between the personality traits included in Sumer's model and crash involvement (e.g., af Wåhlberg, Barraclough, & Freeman, 2017; Constatinou, Panayiotou, Konstantinou, Loutsiou-Ladd, & Kapardis, 2011; Qu et al., 2016). Qu et al., (2016) found that aggression, sensation and thrill-seeking moderately or weakly (0.01 – 0.16) correlated with minor accidents. Constatinou et al. (2011) supported Sumer's proposition that personality is a distal factor that does not correlate directly with crash outcomes but is an indirect predictor that influences the behaviours that contribute to crashes (Furnham & Saipe, 1993; Ulleberg & Rundmo, 2003). For instance, Rimmö & Åberg (2014) proposed that violations mediate the relationship between sensation seeking and crash

involvement. Garrity and Demick (2001) found significant associations between mood (tension) and negative driving and significant inter-correlations among trait anxiety, excitement seeking and risky driving have been reported (Oltedal & Rundmo, 2006). Personality factors are therefore modelled as predictors (distal) of driving behaviours that are (proximal) stronger predictors of crash involvement (Sumer, 2003).

1.6.3.3.1 Personality antecedents of violations

Personality variables have been implicated in the occurrence of road crashes (Cohen & Janicki-Deverts, 2012; Mallia et al, 2015). Problem behaviour theory (Jessor & Jessor, 1977) stated that some individuals with certain personality characteristic have behaviours that are more problematic on the road. Brown et al (2016) found that some individual drivers were prone to reckless driving and had repeated incidents of aberrant driving and collisions. Those drivers involved in fatal crashes exhibited some other problematic behaviour such as substance use while driving or prior to driving. Such individuals may also defy authorities and often violate traffic regulations (Brown et al, 2016; Ivernson & Rudmo, 2002). Among young novice drivers in the UK and Australia personality traits relevant to driving were related to their crash involvement with personality traits more strongly related to violations than to driving skills (Clarke, Ward, & Truman, 2005; Ivers et al., 2009). Some at-risk personality traits identified in the literature that are crucial to crash risks include aggression, impulsivity and sensation seeking among others.

Aggression is any behaviour ‘that is intended to physically, emotionally or psychologically harm another within the driving environment’ (Hennessy & Wiesenthal, 2001: 661). Aggression in the context of driving involves the operation of a vehicle in a manner that poses danger or is likely to endanger people or property (Martinez, 1997). Impulsivity is the tendency

to act without foresight and deliberation and without evaluation of consequences (Bıçaksız & Özkan, 2016). Sensation seeking involves seeking 'novel, varied, complex, intense sensations and experiences with the willingness on the part of the individual to take physical, social, legal and financial risks for the sake of such experiences' (Zukerman, 1994: 14). Individuals with such traits have the 'optimistic tendency to approach novel stimuli and explore the environment' (Zukerman, 1994: 25). Risk taking in driving was found to relate to impulsiveness (Oltedal & Rundmo, 2006; Ulleberg, 2001). In other studies thrill (sensation) seeking and aggressive tendencies have been related to speeding violations (Beck, Daughters, & Ali, 2013; Beck, Wang, & Yan, 2012; Coeugnet, Miller, Anceaux, & Naveteur, 2013). Aggressive tendencies, especially among younger drivers, have been identified as a predisposing factor that increases the likelihood of engaging in risky driving (violations) (Begg & Langley, 2004; Ulleberg, 2001).

1.6.3.3.2 Personality antecedents of errors

Rike, Johansen, Ulleberg, Lundqvist, & Schanke (2018) argued that effective driving depends on self-regulation that requires the evaluation of one's functional abilities and limitations. Similar to the links between violations and personality factors discussed above personality factors including impulsivity and aggressive personality characteristics have been linked with vulnerabilities to stress and commission of errors among professional drivers (Matthews, 2002). Using the transactional stress model, Mathews (2002) argued that personality factors influence a professional driver's cognitive stress process. These stressors affect their interpretation of information that in turn affects driving performance outcomes such as errors (Mathews, 2002).

1.6.3.3.3 Fatalism and attributions of crash involvement

Causal attributions in road crashes are necessary for preventive actions (Kouabenan, 1998). Fatalism encompasses one, or combination of the following; 1) perceived lack of (internal) control over external events (Davison, Fankel, & Smith, 1992; Neff & Hoppe, 1993; Straughan & Seow, 1998), 2) belief in fate, luck, destiny and predetermination of events (Cohen & Nisbett, 1998; Davison et al., 1992; Straughan & Seow, 1998), and 3) pessimism, the feeling of hopelessness and powerlessness (Scheier & Bridges, 1995; Powe & Johnson, 1995). Such beliefs were specified as distal factors in the Contextual Mediated Model (Sumer, 2003). Even though there is limited evidence on the effect of beliefs on driver crash involvement, the possibility that beliefs are important to safety and crash involvement for drivers is consistent with the literature discussed to this point. Crash prevention involves behaviour change (Evans, 1996) however fatalistic beliefs are correlated with lower intentions to change behavior (Powe & Finnie, 2003). Fatalism influences attitude toward safety (Rundmo & Hale, 2003). It has been suggested that accident analysis differs between experts and laymen in terms of values and beliefs, norms, attitudes and common experiences influence of the individual (Kruysse, & jan Wijlhuizen, 1992). Fatalistic beliefs and attributions have been found to influence many forms of risk assessment and risk-taking behaviours for both experts and laymen and this affects risk management efforts (Slovic, Fischhoff, & Lichtenstein, 1981). Biases in judgements regarding risk and crashes may be situated in the culture that defines values, beliefs and experiences shared by people of the same social group.

Fatalism is often construed negatively in the literature (Powe et al., 2005) however the dimension of the concept; determinism that concerns predictability of events, the belief in fate, destiny and luck often produces optimism and give people positive outlook. Fatalism is influenced by religious beliefs and serves as a protective factor against negative expectations;

thus religion conferring invulnerability to negative events (Gearing, & Lizardi, 2009; Powell, Shahabi, & Thoresen, 2003).

1.6.4 Potential distal factors not included in Sumer's model

Other relevant crash risk factors that were not explicitly highlighted in Sumer's model but may be salient to crashes include safety attitudes (e.g., risk perception) cognitive factors (e.g., distraction) and psychosocial factors (e.g., driver stress and fatigue) and anxiety. Evidence for their importance in the Western world has already been documented, as discussed below.

1.6.4.1 Influence of traffic safety attitudes on traffic violations: The Theory of Planned Behaviour (Ajzen 1991)

The Theory of Planned Behaviour (Ajzen, 1988, 1991) has often been applied to driving (e.g., Conner et al., 2007; Parker, Manstead, & Stradling, 1995; Poulter et al., 2008; Rowe et al., 2016). The theory holds that intentions to perform different kinds of behaviours can be predicted from attitudes toward the behaviour, the strength of the subjective norms (opinions of significant others), and perceived behavioural control. The behavioural control is defined by the extent to which the individual believes the behaviour in question is under his or her volitional control (Ajzen, 1988). The intention, along with perceptions of behavioural control, determines actual behaviour. Consistent with the theory (Ajzen, 1991), traffic violations may be motivated by intentions to engage in such acts (Conner et al., 2007; Elliott, Armitage, & Baughan, 2004, 2007; Poulter et al., 2008) unlike errors that arise out of cognitive failures.

According to the Theory of Planned Behaviour, attitudes are determined by a set of positive and negative beliefs regarding the behaviour. For example, a belief that speeding is more likely to result in crashes along with a negative evaluation of crashing will lead to a formation of a

negative attitude towards speeding and may reduce actual speeding behaviour (Armitage, & Conner, 2001; Elliott, Armitage, & Baughan, 2004, 2007). To demonstrate this, it was demonstrated that drivers' intention and beliefs influenced their speed limit compliance behaviour through attitudes, subjective norms and control beliefs (Elliott, Armitage, & Baughan, 2005).

There is evidence that safety attitudes develop during the pre-driving period. Waylen and McKenna (2008) found that safety in attitudes in young adolescents show the same correlates as in the driving population. Using the Theory of Planned Behaviour attitudes, subjective norms and behavioural control were also found to underlie intentions to speed and engage in distracting behaviour (mobile phone use) among pre-drivers (Rowe et al., 2016). It has been found that traffic safety attitudes and behavioural intentions among drivers are developed both at pre and post-training and licensing stages (Rowe, Maughan, Gregory, & Eley 2013b). Safety attitudes among trainees predicted future violations once a license was obtained (Rowe et al. 2013b). Traffic safety attitudes are thus important and their origins are in the pre-driving period.

A prominent safety attitude in the driving behaviour literature that may be distal to crash involvement is risk perception. Risk perception represents perception of the likelihood of damage occurring during driving in general and relates to driving style (Brown, & Groeger, 1998). This contrasts with hazard perception which involves perceiving a crash risk developing in a specific driving situation and is a component of driving skill. Helweg-Larsen and Shepperd (2001) suggested that risk perception is a determinant of health behaviour where the riskier a behaviour is perceived, the less likely it is that an individual will perform that behaviour. In driving task risk perception has been found to influence information processing and decision

making (Wang, Hensher, & Ton, 2002). Lower levels of perceived risk of actions have been linked to unsafe driving practices (Glendon, McNally, Jarvis, Chalmers, & Salis, 2014; Rhodes & Pivik, 2011) and perceived risk has been shown to correlate with self-reported speeding (Ryb, Dischinger, Kufera, & Read, 2006). Horvath and Zuckerman (1993) specified that a competence may increase with involvement in risky behaviour that does not result in negative consequences, such as injury or penalty. Therefore, risk perception may be regarded as a consequence, but not a cause of behaviour (Ulleberg & Rundmo, 2003). The evidence on the direction of effect between risk perception and driving behaviour is inconclusive and may be reciprocal.

The links between risk perception and driving behaviour have been modelled in Risk Homeostasis Theory (RHT) and Risk Compensation Theory (RCT) (Wilde, 1976, 1998). The theories that are known as behavioural adaptation theories contend that human beings change their behaviour based on the degree of risk perceived. Related to road user behaviour, Risk Homeostasis Theory (Wilde, 1998) argues that drivers change their behaviour as a result of the risk perceived in the driving environment or in engaging in a particular behaviour (Elvik & Vaa, 2004). Risk Homeostasis Theory posits that in order to engage in a behaviour, the driver weighs the expected benefits against the costs to determine the target level of risk. At every point in time, the driver compares the personal target level of risk to anticipated or experienced risk and attempts to reduce the difference to zero (Wilde, Robertson & Pless, 2002). For instance, drivers are more likely to be cautious when driving on a bad road or in bad weather for fear of crashing (High-risk perception). However, when the threatening condition goes away (on moving to a good road or better weather) they are more likely to modify their behaviour and drive with less caution (low-risk perception). Wilde et al. (2002) argued that road safety interventions may be ineffective unless they directly affect the amount of risk that

individual road users are willing to take (target level of risk). For instance, putting on the seatbelt may make a driver feel safer and is therefore encouraged to drive riskily (Evans, 1986; Gamble & Walker, 2016). So the safety feeling rather compensates for the risk to be perceived. Risk compensation may therefore act as a distal factor and work by increasing violations that are proximal to crashes when other aspects of the situation are perceived as safer.

1.6.4.2 Cognitive factors as distal predictors of crash involvement

1.6.4.2.1 Influence of attention and executive functions on driving behaviour

Aksan et al. (2013) demonstrated that a set of cognitive factors including executive functions are involved in complex task performance such as driving. Executive functions refer to brain functions related to the regulation of behaviour and organization of cognition (Ardila, Pineda, & Rosselli, 2000). Executive functions represent an individual's capacities for goal formulation, planning and successfully carrying out such plans and are responsible for independent, creative and socially constructive behaviour (Lezak, 1982). Different but related sets of executive function domains have been linked to the performance of complex tasks by different researchers. For instance, Luria (1973) demonstrated the role of initiation, maintenance and cessation of action; abstract and conceptual thinking; and goal-directed behaviour in a driving task. Positive relationships were found between executive functions and self-reports of real-world risk-taking regarding drug use, sex and driving in young adolescents (13-17) and young adults (18-22) (Pharo, Sim, Graham, Gross, & Hayne, 2011).

Executive functions can link to both violations and errors in driving. Anderson et al. (2012) identified visio-spatial construction, the speed of processing and attention shifting to be crucial to driving performance. Aksan et al. (2015) found that attention shifting, performing a secondary task while driving and speed of processing significantly predicted safety errors. There is evidence for the role of executive functions in the commission of errors (e.g., Mäntylä,

Karlsson, & Marklund, 2009; Patrick, Blair, & Maggs, 2008). For example Mäntylä et al. (2009) linked poorer working memory to more errors in a simulated driving task.

A further demonstration of the importance of cognitive factors in driving is provided by the influence of distraction on road crashes (Cordazzo, Scalifa, & Ross. 2016; Governors Highway Safety Association, 2011). It has been found that the rate of truck driver crashes, and near-crashes increased as the level of distraction such as text messaging increased (Olson, Hanowski, Hickman, & Bocanegra, 2009). Distracted driving refers to 'diversion of attention from activities critical for safe driving toward a competing activity' (Regan, Lee, & Young, 2008: 31). Distractions may take the form of auditory and visual processes that interfere with concentrating on the driving task. It may come from inside the vehicle (e.g., peer passenger influence), or factors in the external driving environment (Kahn, Cisneros, Lotfipour, Imani, & Chakravarthy, 2015).

Mobile phones are one common source of distraction. The prevalence of using a cell phone while driving at least once in the past 30 days among individuals aged 18-69 ranged from 21% for the UK to 69% in the US (Kahn et al., 2015). Using a cell phone while driving has been found to contribute to 10% of fatal crashes and 17% of injury crashes in the United States and Seven European countries (Naumann & Dellinger, 2013). The use of a hands free device was proposed to reduce the effect of the distraction from mobile phone use while driving (Regan et al., 2008; Redelmeier & Tibashirani, 1997) but researchers (e.g., Saifuzzaman, Haque, Zheng, & Washington, 2015) found a negative effect for both the hands free and handheld conditions on car following behaviour variables; speed, spacing and time headway. Hands-free phone use also increased crash risks (McEvoy, Stevenson, & Woodward, 2007). Therefore, the link between distracted driving and crash rates may not be a result of the manual performance of

two tasks that takes the drivers visual attention but it is the competition for cognitive resources that increases crash risk.

Distraction of this form is likely to increase crash risk through increasing errors, such as failures of hazard perception (Savage et al., 2013). Allowing oneself to be distracted while driving can itself be thought of as a violation. Choosing to engage in a distracting activity such as using a phone, note writing, interaction with dispatch equipment, or map reading are considered as violations (Governors Highway Safety Association, 2011). Overall the pieces of evidence discussed under cognitive factors of crash involvement point to a crucial role of cognitive factors in safe driving. Based on the nature of the link between the cognitive factors and road crashes they are more likely to be distal to crash involvement as they directly influence crash risks (violations and errors) (Sumer, 2003).

1.6.4.3 Psychosocial factors as distal predictors of crash involvement

1.6.4.3.1 Driver stress

Associations have been found between driving stress indices and crash involvement (Lagarde et al., 2004; Legree, Heffner, Psotka, Martin, & Medsker, 2003). Driver stress may operate as a distal factor that influences the more proximal aspects of risky driving behaviour (Ge, Qu, Jiang, Du, & Kan-Zhang, 2014) and arises from the social (Hill & Boyle, 2007) and physical environment (Legree et al., 2003; Rowden, Matthews, Watson, & Biggs, 2011). Stress arises from the body's inability to adapt to environmental demands (Selye, 1936 cited in Ge et al., 2014). High levels of stress reduce the efficiency of attention, working memory and executive functioning (Ashcraft & Kirk, 2001; Eysenck & Calvo, 1992; Moriya & Sugiura, 2012), and perceptual-motor performance (van Galen & van Huygevoort, 2000). Mathews (2002) defined driver stress as responses associated with ‘perception’ and ‘evaluation’ of the process of

driving when it is dangerous or demanding relative to the individual driver's capabilities. Stress in driving context is measured through self-report inventories that cover stress indices such as; dislike of driving, heightened alertness, frustration and fatigue (Mathews, Dorn, & Gledon, 1991; Qu, Zhang, Zhao, Zhang, & Ge, 2016). Ge et al. (2014) found that stress factors correlated with several forms of dangerous driving including risk-taking. Stress may arise when the driver cannot manage driving related hazards (Matthews et al., 1997; Matthews, 2002) such as overtaking or maintaining position when being tailgated (Rowden et al., 2011). Situations such as moving through traffic congestion may be strenuous to motorists and elicit stress (Emo, Mathews & Funke, 2016).

A major but neglected stressor that impacts negatively on driving performance is a driver's emotional status influenced by life events and daily frustrations (Cohen & Janicki-Deverts, 2012). Findings from data on 410 drivers over a 7 year period revealed that drivers who were divorced had more violations and crashes and that the incidents were mainly recorded immediately to and just after filing for divorce (McMurray, 1970). Similarly, Largarde et al. (2004) found self-reported driving faults were four times higher for drivers going through a marital separation. Among military personnel, recent combat experience predicted risky and aggressive driving behaviour related to crash involvement (Mitra-Sarkar & Andreas, 2009).

Pressure from the social environment has been identified as a crash risk (Horvath, Lewis, & Watson, 2012). Passengers provide an additional source of pressure that influences crash risks. Higher crash risks were observed among teenage drivers who had other teenagers as passengers (Chen, Baker, Braver, & Li, 2000; Preusser, Ferguson, & Williams, 1998; Williams, 2001; Williams & Ferguson, 2002). Pressure to engage in aberrant driving behaviours such as speeding and dangerous overtaking, use of inappropriate lanes may be actively (direct verbal

encouragement) or passively (perceived) from passengers (Horvath et al., 2012). In a study with high school seniors in California, two-fifths of the participants reported having been pressurized by their passengers. Yelling, tickling the driver and attempting to use ‘vehicle control' were some forms of communicating the pressure that the driver perceives (Heck & Carlos, 2008). Steinberg (2004) has shown that the mere presence of peers watching the driver’s performance may result in higher risk-taking.

In response to social pressures and traumatic life experience, it has been found that people may drive in ways that increase violations such as speeding, maintaining shorter headway distance and dangerous overtaking (Legree et al., 2003). In terms of Sumer’s framework, driver stress might increase crash risk through a number of proximal aspects of driving behaviour. Stress disrupts sustained attention and the ability to detect potential hazards while driving (Dorn & Brown, 2003) and as well as affecting how critical incidents are handled in the course of driving (Cunningham & Regan, 2017). Driving stress was found to increase driving errors (Lagarde et al., 2004; Legree et al., 2003; Norris, Mathews, & Riad, 2000). Additionally, stressors increase the level of physiological arousal that in turn could influence risk-taking behaviours (Cima, Smeets, & Jelicic, 2008; Van De Grone, Kempes, van El, Rinne, & Pieters, 2014). Poor judgment and weak inhibitory control that results from stress effects have been linked with risk-taking attitudes among drivers (Farrah,Yechiam, Bekhor, Toledo, & Polus, 2008; Jongen, Brijs, Komlos, Brijs, & Wets, 2011). Kemeny (2003) demonstrated that stressors reduce an individual’s risk appraisal systems making them perceive risky situations to be less threatening.

1.6.4.3.2 Fatigued driving and crash risks

Stress factors are hypothesised to influence errors and violations as well as crash risks and therefore they should be considered distal crash factors in Sumer's framework. Driving while tired may be one specific form of driving stress. Fatigued driving has been reported among drivers (Findley, Unverzagt, & Suratt, 1988; Smolensky, Di Milia, Ohayon, & Philip, 2011) especially for those over age 30 (Senaratna et al., 2017). Driving under conditions of tiredness has been under recognised as a crash risk factor (Pennay, 2008; Radun, Radun, Wahde, Watling, & Kecklund, 2015). It has been estimated that driving while tired contributes to approximately 20% of all fatal road crashes (Connor, Norton, & Ameratunga 2002; Kecklund, Anund, Wahlström, & Akerstedt, 2012). Nordbakke and Sagberg (2007) reported that many drivers (73%) would continue to drive even when aware of their increasing levels of tiredness. Increased mileage and increased driving hours were associated with increased violations on the road (de Winter & Dodou, 2016). Increased violations serve as a proximal pathway between the distal factor; fatigue and crash involvement. There is evidence that fatigue and sleepiness increase the risk of crashing (Philip et al., 2010; Smith, Horswill, Chambers, & Wetton, 2009) that might occur through increasing errors. Fatigue reduces vigilance and impairs hazard perception (Smith et al., 2009).

1.6.4.4 Relationship between anxiety and crash risks

Anxiety is characterised by a feeling of tension and uneasiness at a real or perceived threat and takes the form in an individual state or trait (Rachmann, 2013). People with high trait anxiety were found to be poor in managing threatening situations when confronted with one (Byrne, 2003; Trick, Brandigampola & Enns, 2012). Spielberger (1972: 112) stated that 'individuals with high trait-anxiety are more likely to perceive situations as threatening and respond with intense state-anxious reactions'. The process of driving involves dealing with several

challenging situations such as handling a sudden burst of tyres, mechanical failures while in motion, avoiding an oncoming vehicle in one's lane, planning and executing overtaking and negotiating sharp curves. Several behaviours such as the close following by a vehicle, use of the horn to demand access can by themselves create anxiety among drivers resulting in errors (Dula, Adams, Miesner, & Leonard, 2010). Costa and McRae (1992) found a significant positive relationship between anxiety and negative affect (fear, nervousness and depressed mood) which may influence a driver's interpretation of the driving environment. Anxiety may impact driving by restricting adaptive behaviours on the road (Moller & Siguroardottir, 2009). Anxious individuals may report failures of observation in the course of their driving (e.g., failing to check mirrors before changing lanes; Shahar, 2009) and also record increased lapses on the road (e.g., attentional and memory failures) (Wong, Mahar & Titchener, 2015).

A positive relationship has been found between trait anxiety and risky driving behaviours (Panayiotou, 2015). It has also been found that drivers with higher levels of anxiety engaged in more dangerous violations such as tailgating, driving under the influence of substances (Dula et al., 2010) and going beyond speed limits (Roidl, Frehse, & Hoeger, 2014). The effects might be due to succumbing to perceived work pressure (Zhang, Yau, Zhang, & Li, 2016) or the comorbidity between anxiety and disruptive disorders (Roy, Oldehinkel, Verhulst, Ormel, & Hartman, 2014). Based on the review of the relationship between anxiety and driving behaviour, it is predicted that anxiety is more likely to relate indirectly (i.e., as a distal predictor) to crashes via driving errors.

1.7 Revised Contextual Mediated Model

Based on the above review of literature from the developed world, Sumer's (2003) model might benefit from some revision. The revised model (Figure 1.7) considers the majority of the

factors proposed by Sumer (2003) and some others not covered by the model (e.g., distracted driving). The revised model proposes that the factors; personality (e.g., aggression and impulsivity), anxiety, driver stress factors (e.g., fatigue), attitudes such as risk perception, fatalism, distraction and safety maintenance practices may also relate directly to crashes and also indirectly via the proximal factors. Additionally, proximal factors; violations and errors proposed by Sumer (2003) as well as hazard monitoring, are more likely to mediate the links between the distal factors and crash involvement and as such has direct effects on crash involvement. The proximal elements; speeding and drinking as proposed by the Sumer's model relate to violations as defined by Reason et al. (1990) and the safety skills relate to hazard monitoring as well as overlapping with errors. Similarly, aberrant driving behaviours specified by Sumer refer to both errors and violations in the driving behaviour literature (Panayiotou, 2015).

The Contextual Mediated Model, as revised, further proposes paths from personality factors such as extraversion, agreeableness, conscientiousness and openness to crashes that are mediated by errors and violations. The path from neuroticism to crashes is predicted to be mediated by only errors. Impulsivity that is linked to inattention is a well-documented precursor to errors and increases risk taking; thus impulsivity is modelled to relate indirectly to crashes via errors, violations and hazard monitoring. Fatalism was expected to relate to crash involvement through violations (Kouabenan, 1998). However, with higher fatalism one might also pay less attention to driving so errors might be higher too; thus fatalism is predicted to relate indirectly to crashes via errors. Anxiety and risk perception were predicted to relate to crash involvement indirectly through the mediators; hazard monitoring, violations and errors (Sumer, 2003).

Socio-demographic factors are modelled to relate to crash involvement both directly and indirectly through the mediators; hazard monitoring, violations and errors. The paths from stress indices; dislike for driving and fatigue to crashes will be mediated by hazard monitoring and errors (Ge et al., 2014) while the path from aggression to crashes is expected to be mediated by hazard monitoring, errors and violations. It is expected that the path from thrill to crashes will be mediated by hazard monitoring and violations while distraction is hypothesized to relate to crashes via hazard monitoring, violations and errors (Olson et al., 2009). Links between safety maintenance practices and crash involvement are predicted to involve both a direct pathway and a pathway mediated by errors. As a model to guide exploration most potential causal pathways in the model were left intact. Where paths are not specified this implies a strong prediction that the effect of a particular distal factor is not mediated by a particular proximal factor.

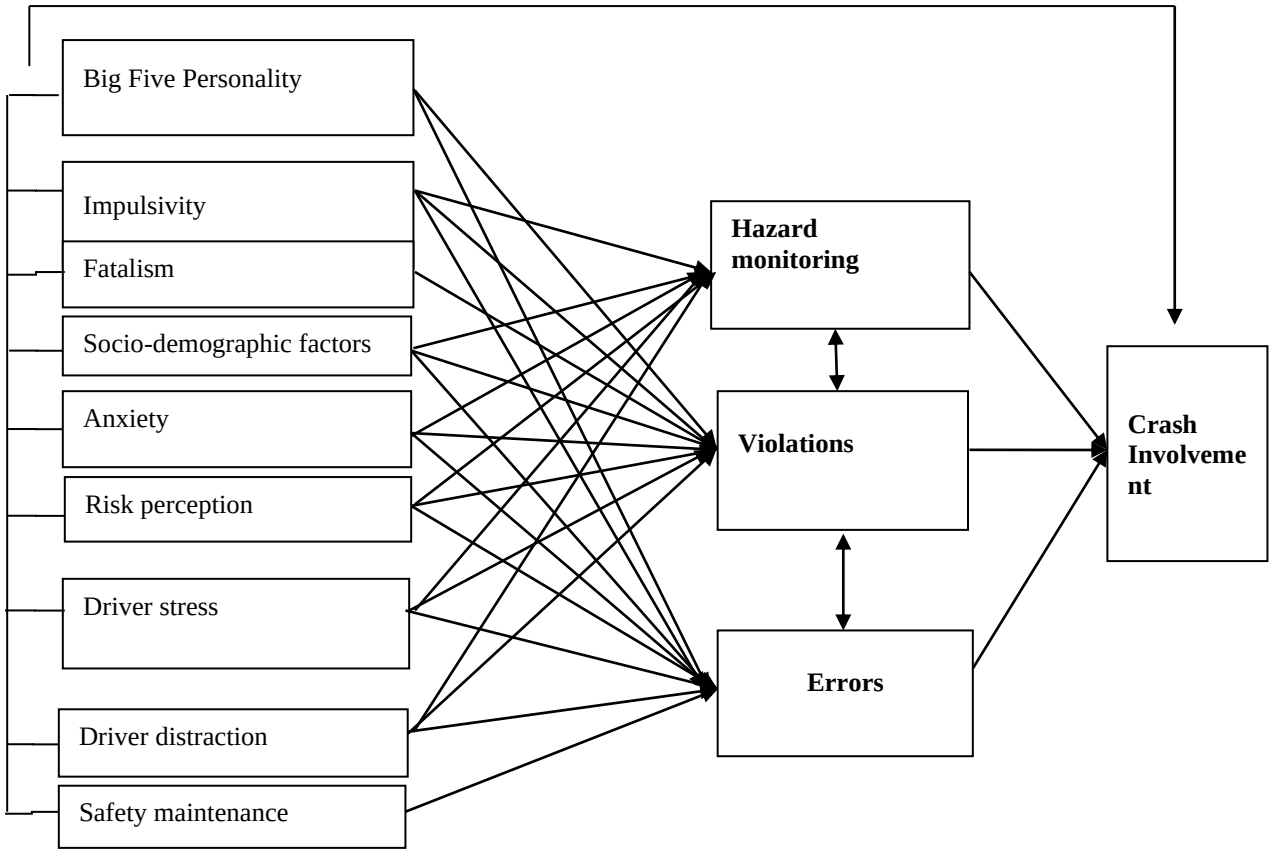

Fig 1.7 Revised hypothesised contextual mediated model of the behavioural predictors of road crashes (adapted from Sumer, 2003, p.951). **Note:** The figure is somewhat simplified and does not distinguish the different facets of personality.

1.8 Applicability of the contextual mediated model factors to driving in the Global South

The Contextual Mediated Model (Sumer, 2003), perhaps improved by the additions suggested above, provides a useful framework to summarise work on road safety risk factors in the Western literature. The model may apply in part to driving in developing countries because some of the factors are shared between developed countries and the Global South. For example, vehicular traffic congestions associated with driving in developed countries and behaviours such as engaging in distracted driving with cell phones while driving are also common in the Global South (Largarde, 2007). The presentation of some the factors in the Global South context may differ due to the variations in traffic culture as discussed in Section 1.6. For

instance, the evidence indicates the harmful effect stress and fatigued driving has been considered in Western literature but as Zhang et al. (2016) noted, little research attention has been given to these factors in low and middle-income countries. The effects of stressful life events and daily stressors may be worse in the Global South that are known to have more economic and social challenges.

The high rate of poverty, infectious diseases (WHO, 2015) and other daily social stressors that are common in the Global South are notable sources of stressors. Closely linked to this is the profession of commercial driving which is more common in the Global South than in developed countries. In the light of the discussion of risk factors of crashes in the Western world, it is likely that there may be other factors not covered by the modified contextual mediated model that may also be salient to driving in developing countries. As such, there is a need for an updated/revised model that may largely apply to driving in the Global South.

1.9 Rationale for the present study in Ghana

In terms of crash reduction strategy, there is limited evidence as to the use of behavioural interventions (e.g., improving legislation and enforcement) in the Global South where the greater proportion of crashes occur (Largarde, 2007). The WHO, (2015) and the World Bank Report (Peden, 2004) identified that a substantial gap (in knowledge on burden and road crash interventions) separates high-income countries from low- and middle- income ones. To attest to this, a meta-analytical review on road traffic injury intervention measures in the Global South by Staton et al. (2016) found 18 studies from 11 low and middle-income countries out of a total of 8560 articles from the search. Only four were from Sub-Saharan Africa (Staton et al., 2016). Within the studies reviewed from the Global South, behavioural targets represented only a small proportion (less than 10%) of road crash preventive strategies (Staton et al., 2016).

Crash and fatality reduction targets set by many low and middle-income countries are not being met (WHO, 2015). For instance, the Sustainable Development Goals (SDG-3) which expanded on the Millennium Development Goals (MDG) ratified by UN member states targets to reduce road traffic fatalities from where they stood in 2015 by 50% in each member state by the year 2020. However, from the latest crash statistics for Ghana (NRSC report, 2017, 2018) the achievement of the SDG-3 on road traffic injury appears unlikely, as the fatality rates (absolute number of fatalities) have been increasing over time. The WHO (2015) has advocated that a change in road user behaviour as a critical component of the holistic 'Safe Systems' approach to road crashes. To this end, behavioural factors then become more prominent in the holistic approach since they are the main contributors to driver crashes.

In Ghana, the evidence on factors in road crashes are limited, but it has been suggested that environmental factors such poor road network are major determinants (Afukaar, Agyemang, Debrah, & Ackaah, 2006; Mock et al., 1999; NRSC, 2016). However as discussed below, a poor road network prevents fast driving and therefore may keep fatality rates lower. Other contributory factors such as risky driving behaviours (e.g., speeding), drunk driving, loading beyond the capacity of the vehicle, use of mobile phones when driving, and failure to use a seat belt have also been identified (Afukaar, Antwi, & Ofosu-Amaah, 2003; Ayeboo, 2009; Mock et al, 1999; NRSC, 2007, 2014; Teye Kwadjo, 2019). Whereas these studies from Ghana may represent an effort to investigate and identify some behavioural factors (e.g., breaking speed limits) that are crucial to crash reduction in the developed world, there is limited evidence about the links between these factors and crash risks and the extent to which these factors influence crash involvement in Ghana and other countries in the Global South. There are some road crash preventive efforts in Ghana. For example, The National Road Safety Strategies (I, II & III, [NRSC, 2012]), however, there is no evidence regarding their effectiveness. The

strategies target to reduce crash fatalities in Ghana by 50% from 2011-2020 through ensuring safer roads, safer vehicles, safer road user behaviour (integrated speed management programme), post-crash response and improved enforcement. While Strategies I and II have failed based on the relative increase in the fatalities (12-15% each year from 2012), the effect of Strategy III was small (NRSC, 2016).

Contrary to some of the findings especially related to road infrastructure and crashes, the crash statistics in Ghana indicate that the continuous improvement of Ghana's road networks has brought in its wake increased crashes. More frequent and fatal crashes happen on the improved road networks than on dilapidated roads (Mends-Brew, Dadzie, Dadson, & Amoamah, 2018; NRSC, 2015). Such improved roads rather facilitate faster travel allowing for higher impact crashes, particularly in a context where training, safety culture and enforcement may not be fully effective (Hosseinpour, Yahaya, & Sadullah, 2014). Mock et al. (1999) observed that there was an underemphasis on crash prevention models in Ghana. Therefore, there is a need for studies, which examine the extent to which driver behaviour models based on data from developed countries will apply to sub-Saharan Africa and whether there are additional proximal and distal factors that are important in the Global South context. These can then inform the development of appropriate intervention and enforcement policies. The empirical investigation into behavioural factors influencing driver crash risks in the present study is therefore timely.

1.10 Aims of the thesis

1. To determine the extent to which driver crash prediction models from the Western world generalises to the context of Ghana.
2. To identify behavioural risk factors of driver crashes that are important in Ghana but have not been identified in the existing literature.

1.11 Outline of the research programme

Chapter Two presents Study 1; a qualitative exploration of factors influencing driving behaviour and driver crash risks in commercial drivers (a very common class of drivers) in Ghana. This study aimed to inform a quantitative study by providing an insight into the specific driver crash risks factors peculiar to Ghana (if any) and whether factors common in the Western literature could also be identified in Ghana. These results are used to revise the modified contextual model linking distal factors to crash involvement via proximal factors. Chapter Three reports Study 2; the validation of the Driver Behaviour Questionnaire (DBQ) in the Ghanaian driving culture. The aim was to determine the applicability of the 28 item version DBQ to Ghana in terms of measuring the proximal error and violation components of the contextual model in preparation for applying it in a larger scale study that can test a number of aspects of the proposed links between distal and proximal predictors of crash involvement. Chapter Four describes the revised contextual mediated model that entails determining the relationship between behavioural factors and driver crash risk; violations and errors as measured by the DBQ among a Ghanaian sample (Study 3). The results were compared to data collected using the same measures in a sample of UK drivers, to provide a comparison that can identify which components of the model identified in Ghana are specific to Ghana. Chapter Five (general discussion) considers the findings made across the three studies. This is followed by conclusion and recommendations for policy, practice and research.

Chapter 2: Behavioural influences on driver crash risks in Ghana: A qualitative study of commercial passenger drivers

Abstract

Road traffic crashes in the Global South pose serious public health challenges with Africa recording the highest fatalities globally. This qualitative study explores factors influencing crash risks for commercial drivers in Ghana. The aim is to identify behavioural risk factors for driver crashes that are important in Ghana but have not been identified in the existing literature. Twenty commercial drivers of varied ages and experience were sampled from 7 major lorry terminals in 3 regions (Greater Accra, Ashanti, and Volta) of Ghana. Data were collected through semi-structured interviews. The participants identified some issues that are shared with drivers in the developed world, though moderated by the Ghanaian context. These included working pressures (e.g., fatigued driving), speeding, distracted driving and inadequate vehicle maintenance. Other factors identified by the participants are infrequently considered in research addressing driving behaviour in developed countries. These included aggressive competition over passengers and corruption (e.g., improper licensing practices) among others. The findings have implications for modelling crash risk in Ghana.

2.1. Introduction

As indicated in Chapter One, mortality from road crashes is highest in the Global South with the African region having the highest fatality-rate (WHO, 2018) despite being the least motorised of all the world regions. As noted by Largarde (2007), research addressing road safety in African countries is disproportionately sparse relative to the magnitude of the problem. The modified contextual model that links distal factors to crash involvement via proximal factors (see Chapter 1, Fig. 1.7 and section 1.7 for coverage) covered the majority of the factors proposed by Sumer (2003). However, there may be other crash risk factors not covered by the contextual model that may be specific to Global South settings. The revised model will be applied to test the extent to which driver behaviour models based on data from developed countries will be applicable to sub-Saharan Africa and whether there are additional proximal and distal factors that are important in the Global South context.

This chapter focuses on Ghana which exemplifies the contribution of road crashes to mortality and morbidity in Africa (Afukaar et al., 2006). Fuelled by increasing population and motorisation, the death rate from road crashes has grown 12-15% annually since 2008 (NRSC, 2016). Commercial drivers are overrepresented in road crashes in Ghana (Ackaah & Adonteng, 2011; NRSC, 2007; Quartey, 2010). About 40% of reported fatalities in Ghana involve commercial passenger vehicles that provide public transport services (NRSC, 2017). These include minibuses, big buses (coaches) and shared taxis that are operated mostly on hire and pay (commission) basis. Commercial drivers therefore constitute an important group of drivers in Ghana whose activities and behaviours are crucial to crash prevention. Variations in working conditions and training have been associated with crash risk among commercial drivers in developed countries (Beanland, Goode, Salmon, & Lenné, 2013; Dorn, 2017; Mathews, Tsuda, Xin, & Ozeki 1999; Zhang, Yau, & Chen, 2013). As described in detail in Chapter 1 (pages 31

– 34) a large body of literature indicates that driving when fatigued increases crash risk (Connor et al., 2002; Smith, Horswill, Chambers, & Wetton, 2009). For example, working under exhaustion is linked to violations of traffic regulations leading to crashes for commercial drivers in the Global South (Nantulya & Muli-Musiime, 2001; WHO, 2004; Zhang, Yau, Zhang, & Li, 2016).

This study explores the potential determinants of road traffic crashes in Ghana as seen from the perspective of commercial drivers. The study aimed to identify behavioural risk factors of driver crashes that are important in Ghana but have not been identified in the existing literature. It is anticipated that a number of factors identified as important in crash risk in developed countries, as discussed in Chapter One, will also be salient in Ghana. Errors and violations are likely to be proximal risks for driver crash. However, characteristics of the road situation in a developing nation such as Ghana might influence the extent to which the driving environment limits and/or promotes these risky driving behaviours. In particular, deficiencies in road traffic law enforcement structures in the developing world have been identified (Nantulya & Reich, 2002; Oleinik, 2016) as being partly responsible for increased crash risks. Corruption in law enforcement (e.g., extortion of money from offending motorists by traffic police) can promote improper training and licensing, and foster traffic rule violations (Bishai, Asiimwe, Abbas, Hyder, & Bazeyo, 2008; Chandran et al., 2014; Nantulya & Reich, 2002). Through bribery and corruption, aberrant and hazardous driving behaviours may go unchecked, and mandatory maintenance practices may be ignored (Nantulya & Reich, 2002).

We adopted a qualitative methodology with semi-structured interviews to provide an initial exploration of the driving situation in Ghana. This was important given that the topic under consideration has not been comprehensively researched in the Ghanaian context. This allows

investigation of issues hypothesised to be important on the basis of literature from the developed world, without constraining the way in which these issues are framed. It also allowed participants to tell us about novel issues that may be specific to the developing world context and therefore will not have been anticipated in the developed world literature. The inductive approach to thematic analysis (Braun & Clarke, 2006; Elo & Kyngas, 2008; Frith & Gleeson, 2004) was used to identify unanticipated insights in the data.

2.2 Method

2.2.1 Participants

Twenty drivers of commercial passenger vehicles were selected through purposive and snowball sampling strategies. The participants were all males, reflecting the male domination of this profession in Ghana. Inclusion criteria required active commercial driving within the last 6 months. Initial contacts were made with the commercial drivers at 7 lorry terminals in Accra metropolis and one each at 2 other regions (Ashanti and Volta) through personal approaches. Participants identified through mutual acquaintance were invited by telephone. Participants were aged between 24 and 63 years *(M = 37.95* years, *SD= 10.6)* and had post-licensing driving experience of between 5 months and 30 years (*M* = 5 years, *SD* = 2.16). Sixteen of the 20 participants (including all those with less than 2 years driving experience) were trained through apprenticeship and were therefore actively driving for between 2 and 3 years prior to being issued with full licence. The remaining 4 had formal driver training (from state approved driver training centres). Nine of the participants usually drove less than 500km per journey, 5 usually drove more than 500km per journey and the remaining 6 did both. Only 3 of the drivers had assistant drivers (another driver that takes over when the primary driver is too fatigued to drive or is indisposed). All the drivers except one (who had no licence at all) had valid driving licences at the time of conducting the interviews. Six (30%) reported being involved in a crash

as a driver during their driving careers. Of these, 3 (15%) had crashed once, 2 (10%) had crashed twice and 1 (5%) had crashed three times. Five (25%) of the participants including the one who held no valid licence usually drive shared taxis of maximum capacities up to 5 passengers. The four held licence '*B' (*designated for cars and cross-country vehicles not exceeding 3000kg). Eight (40%) of the participants usually drive 'Trotro'; mini buses with capacities up to 33 passengers. Of the 8 'Trotro' drivers, 6 held licence '*C' (*designated for goods carrying vehicles, buses/coaches of between 3000-5500kg or 1-33passengers) and 2 held licence '*B'.* Seven (35%) usually drive buses/coaches with capacities of over 33 passengers of which 4 held licence '*D'* (designated for goods carrying vehicles, buses/coaches not exceeding 8000kg) and 3 held licence '*B'.*

Ethical approval was obtained from the Ethics Committee of the Psychology Department at the University of Sheffield UK and from the University of Ghana, Ethics Committee for the Humanities. Participants provided informed consent and were made aware of their right of withdrawal from the study at any time without offering any explanation. Pseudonyms and anonymous quotes are reported to protect anonymity. Data saturation was realised after the 20th interview; the themes that were identified at this stage overlapped with themes already identified in previous interviews. Therefore no further interviews were conducted because it was unlikely that this would lead to the identification of themes beyond those already identified (Guest, Bunce, & Johnson, 2006).

2. 2. 2 Data Collection

The data was collected through face-to-face semi-structured interviews. Participants were first presented with the pre-screening questions that asked whether they were currently driving and if not how long since they last drove. Those who had not driven during the previous 6 months

were excluded. The next phase comprised answering the demographic information questions and the research interview questions. An interview protocol was developed to ensure that both the interviewers and the participants were guided towards discussing the same topic areas. The questions were phrased in a general way (extracted themes were not mentioned in the questions) in order to allow the participants freedom to tell us about the factors that they felt were most relevant. The interview guide (see Appendix A) contained a limited number of simple open-ended questions with further probes that covered daily work schedules, experiences with crashes and contributory factors (e.g., *as a commercial driver how is your typical day like? Briefly tell me about your experiences with crashes/accidents and the factors you might identify as being responsible. Will you tell me a little bit about your training? What has changed about driver training and driving since your training? Will you recommend that anybody at all at any time, once he/she is of age, can go into commercial driving? Why and why not? Is there anything else you want to share concerning the causes of crashes on our roads? What is the greatest priority in increasing road safety in Ghana?).*

Two interviewers backed by two research assistants each from the Department of Psychology, University of Ghana conducted the interviews simultaneously at separate locations/regions of Ghana. The two research assistants were in charge of obtaining informed consent, pre-screening and debriefing. Consistent with the inductive approach, the participants were allowed to narrate (as guided by the interview) their daily experiences out of which all the themes were generated. The respondents based their answers both on their own behaviour and their observations of the behaviour of others. All invited participants were fluent in English which was used for all interviews. The interviews were conducted in the offices of the driver unions (bodies that oversee the daily operational activities of commercial passenger drivers) or at the participants' homes and lasted for 35 minutes on average per driver.

Both interviewers used further probes to enhance the understanding of the participant's experiences. Therefore to ensure methodological rigour, the technique of member checking (Guba & Lincoln, 1985) was adopted to validate and ensure the credibility of the interviewing process and the findings. To achieve this the initial thematic frameworks of 6 participants randomly drawn from both sets of interviews were discussed with the respective participants to ascertain if they reflected the experiences they shared during the interviews. Minor modifications were made to a few of the narratives on the basis of the member checking. Member checking ensures all participants share a common interpretation of their narratives and provides an opportunity for correcting errors, wrong interpretations and understanding of questions and provision of additional information (Marshall & Rossman, 2011). The above process resolved any differences in questioning between the two interviewers.

2.2. 3 Data Analysis

Open coding techniques were employed (Yin, 2012) to analyse the data. Data were coded manually after a verbatim transcription. The analysis was conducted using the 6 phase process recommended by Braun and Clarke (2006) which includes; (1) data familiarization, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes and (6) reporting. Coding units were defined as individual statements, usually a sequence of interrelated sentences, which were relevant to the research objective. The data were coded independently by the principal researcher and by the lead research assistant from the University of Ghana. Inter-rater reliability of 94% was observed for the two raters. Differences in codes were subsequently resolved by discussion.

2.3 Results

Six main themes emerged: (1) working pressure (e.g., fatigued driving), (2) violations (e.g., speeding and aggression), (3) concentration (e.g., distracted driving), (4) training (e.g., inexperience and poor driving skills), (5) behavior of other road users (e.g. dangerous overtaking), and (6) corruption (e.g., improper licensing practices).

2.3.1 Work pressure

Participants discussed a number of factors surrounding work pressure which contribute to the road safety problems. In particular, these included issues surrounding fatigued driving and pursuit of revenue targets.

2.3.1.1 Fatigued driving

Ninety percent of participants, who often worked 18-20 hours per day, 6-7 days per week, confirmed that fatigue and sleepiness were a major issue.

> *"... you have to wake up very early like 4 o'clock am and close late like 12 am ..." (P2)*
> *"...when going on long journeys ... we will not sleep for about three days. Sometimes you will be sleeping while driving ... It happened to me before. I just slept small before I opened my eyes the car was in a trench somewhere" (P13)*

The participants disclosed not having assistant drivers to relieve them when they were tired. Even for the few (15%) of them who indicated they periodically employ "spare drivers" to relieve them, this is not usually to support a long journey but to drive on days when the primary driver is entirely unavailable.

2.3.1.2 Pursuit of revenue targets

All the participants indicated that the fatiguing working conditions are usually due to the pursuit of high revenue targets. Future maintenance and other operational costs demand that they meet certain revenue targets to keep operating. They believed drivers try to address this problem by engaging in violations to maximise income.

"...Many of us drivers to are rushing and the problem is because of the sales you have to make...when there are more passengers like funerals on Saturday, I rush so much so I can get more money to make my sales. Even if the car is for you, after spending money at the shop you are left with something small for yourself so you have to rush whenever there are passengers and you have to work all day. You sometimes become tired but you don't have to stop ..." (P8)

2.3.2 Violations

In relation to the 'violation' theme, participants particularly identified and discussed such behaviours as speeding and aggression, aggressive competition over passengers, obstruction dangerous overtaking, maintenance attitudes, loading practices and substance use among others. These are presented below.

2.3.2.1 Speeding and aggression; the participants commonly cited breaking speed limits to make up for lost time and revenue when there were traffic delays as a contributor to crash risk. Seventeen out of the 20 participants reported being particularly likely to speed in this situation when they were on a road that was in good condition.

"...The reason [for crashing on good roads] is that some of the drivers over speed ... they drive 90, 100 [km/h] and above..'' (P5)
"... For instance, driving from Accra to Kumasi should take about 4 hours but because of the traffic you can be on the road for 6 hours. ... you can be in traffic alone for three hours and when you finally move through you want to speed to cover the time you spent in the traffic especially when the road is good" (P8)

Sixty percent of the participants indicated that speeding capabilities defined the status of a 'true' driver. The ability to drive fast and overtake others was seen as a way of demonstrating superiority in driving.

"*... You see there are some of us [commercial drivers] the moment we get on the good roads we want to exhaust the speed of the car to show everybody that, yes! we can drive" (P13)*
"...and there is that thing that the faster you go the better you are as a driver among the young guys and these things all lead to accidents..." (P18)

2.3.2.2 Aggressive competition over passengers: Participants noted that there was not a formal bus movement timetable. This often resulted in competition over passengers in pursuit of the

revenue that they offer. According to 85% the participants, competition to arrive first at passenger pick-up points often resulted in speeding and dangerous overtaking to get or stay ahead of other commercial drivers, deliberately obstructing competing vehicles to prohibit them from overtaking and use of unapproved routes including driving on the sidewalks.

> "*... some of my colleagues in order that they will get to Accra first and load they will rush, they know if others get to the station before them they will load ahead of them. So, some of the drivers, when they see that, they speed up and pass through some corners or pass the side of the road. If you want to overtake them they will block you ..." (P6)*

As well as dangerous driving, competition for passengers can result in confrontations between drivers involving angry verbal exchanges and physical scuffles.

> *"... Even the fighting among us the drivers over passengers creates a lot of tension and hatred which are all not good for driving. Sometimes you will see us commercial drivers quarrelling in traffic because someone has crossed you or is not giving way for you to pass. It is very common among us the 'trotro' [mini commercial passenger buses that ply short distance in Ghana] drivers ..." (P13)*

2.3.2.3 Obstruction (unintentional and passive) and dangerous overtaking: As well as the deliberate obstructions involved in the competition for passengers discussed above, unintentional obstructions by all road users, including other commercial drivers were identified by 85% of the participants as a major hazard. Unintentional obstructions include other drivers' inability to complete a "U' turn on a single lane road ahead of approaching vehicles. Passive but intentional obstruction include the violations of other motorists who are driving dangerously for their own purposes and also involves large vehicles that do not give way to other motorists who wish to overtake them because of their slower pace.

> *"..Some drivers especially of big cars have been rushing and blocking others. When you are on the road, and other cars are coming you have to give way…allow them so that they can overtake you but many of us commercial drivers we don't allow that" (P6)*
> *"...some drivers just rush to get in front of other, they don't make sure the way in front of them is clear before they do the overtaking or sometimes the way is too narrow...." (P4)*

All 20 participants also believed that many fatal crashes stem from head-on collisions following dangerous overtaking. They indicated that such overtaking occurs in unsafe places such as sharp curves or uneven portions of the road leading to staying for too long on the opposite lane and facing oncoming vehicles.

> *"... There are some drivers who don't have brains, they do overtaking in places that are not good like in curves ... Sometimes when we want to go fast and there is traffic you can see somebody driving on the other road for cars coming the opposite way" (P8)*
> *"... I have ever seen a crash resulting from wrong overtaking. The vehicle that was doing the overtaking did not see that there was another vehicle coming from the opposite direction and when he saw it he applied the brake and before we all see the car has somersaulted thrice killing all the people ..." (P9)*

***2.3.2.4 Attitudes towards maintenance*:** Ninety-five percent of the participants believed a poor maintenance culture contributes to the prevalence of crashes. They reported experiences of several poorly maintained vehicles; some drivers deliberately ignore mechanical faults due to the unwillingness to pay for maintenance. This was partly linked to the majority of the participants hiring the cars that they drive while being responsible for the car's maintenance. The majority (70%) of the participants indicated that the only time their vehicles were serviced by mechanics was when they developed mechanical faults. They did not have scheduled safety checks by qualified mechanics.

> *"... Many of our cars are not properly maintained so they become very dangerous to use" (P3)*
> *" ... ok sometimes your tyres and some other parts of the vehicle are not good but you will say you want to manage it small…small, and by the time you know you get an accident... the only time we go to the shop is when the cars have a problem"(P13)*

Closely linked to the issue of maintenance is the use of worn-out tyres and parts that compromise road safety was reported by all 20 participants.

> *"… the parts are not good, we go to Abossey Okai [market for used car spare parts in Ghana] to buy some parts but they don't last. Sometimes the second-hand parts fail us when we are on the road. Sometimes the old spare parts that have spoiled; they will just paint it and resell to us. The tyres we buy are also not good because the new tyres are very expensive ..." (P8)*

2.3.2.5 Loading practices: Exceeding the carriage capacity of the vehicle (loading more passengers and goods than designated) has been mentioned by 60% of the participants as an unsafe behaviour that often results in crashes. Participants indicated their vehicles become uncontrollable in such situations. They observed that their focus is more on short-term profits than passenger safety.

> *"Those who have load carriers will carry heavy loads on top before there will be passengers. Sometimes we even carry more passengers than the car... and you know some of the cars were not made to carry loads" (P4)*

***2.3.2.6 Alcohol and Substance use*:** The majority of the participants (70%) reported often drinking alcohol or seeing other commercial drivers drink alcohol just before driving. Most participants condemned this behaviour and attributed it to boredom and habits that cannot easily be broken. However, some stated that they often drink and drive without being involved in any crashes;

> *"...when we are feeling sleepy we go to take "akpeteshie" [alcohol] to make us alert but most times it makes you dull because you are drunk. But the drinking sometimes makes you become sharp and alert but if the driver over drinks and is going on a long journey it is a problem, but if it is a short journey I don't think it is a problem" (P4)*
> *"...Many drivers at the station here drink alcohol but they are very experienced so they don't get accidents just anyhow.... As you can see they are selling "akpeteshie" over there and here, two places..." (P11)*

Aside from drinking, 40% of participants reported the use of other substances [e.g., cannabis] during working hours.

> *"...As we are here like this some drivers go to smoke "wee" [cannabis/marijuana] and their eyes become so red like that of some wild animal before they drive..." (P11)*

2.3.3 Concentration

Poor concentration that arises from distraction from passengers, absent-mindedness and mobile phone use among others were equally discussed by the participants as contributing to the road crashes. These issues are presented below.

2.3.3.1 Distraction from passengers: Eighty-five percent of the participants indicated that commercial drivers often get distracted by their passengers. The issues usually concern disagreement over fares and protests over driving speed (with passengers asking them to drive both faster and slower).

> *"....they will be putting pressure on you, let's go, why did you stop? ...and your car is not running… But you're the same person carrying 23 people. Sometimes you become annoyed and turn to watch back and talk to them and if you are not careful accident will happen now... Sometimes when the passengers start misbehaving towards you and you want to correct them other passengers will support them..." (P7)*
> *"... I was "firing" [speeding] a bit then a passenger, a woman behind me started shouting at me as to why I was speeding like that.... so it shocked me and I turned to look at her, before I could turn around and concentrate on the road there was a broken down tipper parked by the road in front of me. To avoid running into it, I left the road [veered off] into the bush...." (P11)*

2.3.3.2 Absent-mindedness; Fifty-five percent of the participants reported often taking their minds off the road when driving. They explained this as having to think about other things including domestic issues and family problems.

> *"...So sometimes the issues from home take your mind out of the car when driving... The problem takes your confidence away and you can't drive well..." (P8)*

2.3.3.3 Mobile phone use: All of the participants the participants reported that using mobile phones is common among commercial drivers just as do other drivers on Ghana's roads. They indicated this impairs their concentration while driving and contributes to crashes.

> *"All of us drivers even all mates now have phones… People drive and talk on phone" (P10)*

2.3.4 Causal beliefs

While the participants accepted that some crashes have natural causes, some (90%) believed that some are linked to supernatural forces which drivers cannot overcome no matter how they behave. The participants indicated that "evil" supernatural influence could result from their own behaviours including the means by which the car was acquired or may be associated with

specific road locations where "evil spirits" dwell. The participants also observed that the commercial drivers may acquire charms either to protect themselves from crashes or to increase the chances of harm coming to other commercial drivers with whom they are in competition.

> *"There are spiritual problems that cause accidents. Sometimes some spirits located in some places like water bodies near the roads when thirsty for blood also cause accidents. Sometimes when it happens we will all say it is the driver but we all know it is not the driver...." (P1)*
> *"Sometimes the cars owners used spiritual or blood money to buy the car so every year especially getting to Christmas there must be blood spill to pay for that money or get more money... there must be accident involving that car, then people will die....." (P3)*

2.3.5 Training and Experience

Training and experience deficits and other factors such as age, confidence and ability to interpret road signs were also discussed by the participants as factors that affect driving performance and contribute to the road crashes. Contrasting concerns were raised regarding driving age, mode of training and experience. These issues are discussed below.

***2.3.5.1 Age, experience and confidence*:** Fifty percent of the participants indicated that aberrant driving behaviours are often engaged in by young drivers who had little or no training. They indicated commercial driving, unlike general driving, is unsuitable for young people.

> *"...we have drivers who are 19 years, 20 years as commercial vehicle drivers. Yeah, 19, 20 to 22..., this is young guys with youthful behaviour who are interested in just plying the road and they are not thinking about their lives and that of other people ... And there is that thing that the faster you go the better you are as a driver among the young guys ..." (P18)*

Some others (45%) blamed elderly drivers for being responsible for the crashes.

> *"... the brains of some of our drivers too are tired and they have to stop driving, ... if you see most of the big buses like the metro buses they are being driven by old people and often there are accidents...some don't see in the night and they make mistakes." (P19)*

Participants also indicated that anxiety and lack of confidence to handle emergency situations contributes to road crashes. Most of the drivers; 15 of the 20 reported experiencing emergency

situations such as a tyre blow-out. According to them, it requires confidence to respond to and manage such situations but they believed that many commercial drivers lack such abilities.

> *".. .there are some of the drivers who naturally have less confidence and such people should not drive. Even if they will drive then it should be private cars but not "trotro" because they always drive mistake …" (P10)*

Some participants also believed that driving experience and skills can compensate for machine failure leading to crashes.

> *"... the second-hand parts fail us when we are on the road … and if you are not experienced there will be accident…" (P8)*

***2.3.5.2 Training and performance*:** Ninety percent of the participants indicated that the majority of commercial drivers have no formal driver training. They mainly learnt under an apprenticeship model. From the accounts, they assume the formal driver training offered by the driving school is the preserve of some types of drivers (private car users, and those seeking formal employment as drivers in organisations) but not commercial drivers. The very few (4 out of 20) commercial drivers who had acquired some formal driving knowledge did not do so for the sole purposes of commercial driving but due to difficulties securing employment as a professional driver. In contrast 60% of the participants indicated that the level of experience and performance of commercial drivers who acquired their driving skills through formal training was low due to shorter practical (hands-on) training periods compared to the apprenticeship model. The participants indicated that the driver apprentices may lack other skills such as interpretation of road signs that might be responsible for the crashes.

> *"… I trained as an auto electrician, and when you are at the shop there is no job so I turned to commercial driving. My mother had a car and through that, I and my brother learnt the driving ourselves." (P8)*

Thirty percent of the participants indicated that even under the apprenticeship model some do not complete the mandatory training period. Therefore, they may have lacked basic knowledge of driving regulations and road safety.

"... For me, I served as a mate and became an apprentice for 4 years before I started driving but now these young boys just if they know how to change the first and second gear, then apply brakes and the clutches, they say they are drivers ..." (P13)

***2.3.5.3 Ability to interpret road signs*:** Although the participants noted the inadequacy of signage on the roads, the majority (70%) reported difficulties interpreting the few road signs that are provided. This they attributed to the low level of formal education among commercial drivers and improper training. Forty-five percent of the participants indicated, the interpretation of road signs is only taught in driving schools. They reported that only a few apprentices who have remained under training for a long time will have learnt to interpret some road signs.

"... I say that before you become a commercial driver you must be educated small before you can do it well. When you see some road signs they write 50 and you have to drive according to the road sign. Some people have not been to school so they are just driving ..." (P14)

2.3.6 Behaviour of other road users

2.3.6.1 Pedestrians and cyclists: Ninety percent of the participants identified pedestrians and cyclists as contributing to road crashes. They reported that pedestrians often cross the road at unsafe places and without looking for oncoming vehicles. They also reported that many cyclists often do not observe safety rules; they ride on the wrong side of the road and cut in front of moving cars risking a crash.

"... Some pedestrians cross anywhere and if they cross you like that and you don't take care you hit them, or brake and summersault, or you will swerve and enter the gutter, or hit something by the road. For example, the N1 Highway, the footbridges there, many pedestrians will not use the footbridge and they will cross the road when you are speeding." (P5)

The participants observed that in some towns the major highways are overrun by pedestrians and street-sellers. In some of the towns, there are no sidewalks. In others, pavements are provided but they are not of sufficient size to cope with the demand.

"... When driving...you will see plenty of people selling on the road. Some days they take more than half of the road ..." (P13)

2.3.7 Corruption

2.3.7.1 Improper licensing practices: All 20 participants identified corruption and cumbersome licensing procedures as contributing to aberrant driving behaviours. Some participants explained that commercial drivers may secure their licenses through illegal means, including bribery.

> *"... Some of the guys do not even go for a driving test, they stay in the house and they bring them their licence. If I tell the truth and die is better…me myself when I went for the driving test they did the eye test and after that, they were frustrating me so I had to pay somebody and I was given my licence." (P2)*

2.3.7.2 Police hold-ups and extortion: Unscheduled roadblocks and checks by the police that involved extortion of money influenced the participants' driving behaviour. Eighty percent of the participants indicated that the extortions make them look out for police check-points creating distress and anxiety. According to the participants, not only will the police extort money but the process often results in long delays.

> *"... We will dodge and pass through some places just to avoid the police...The police too like coming on the road during rush hours and a very small thing they will detain you and collect money from you. You see as part of the pressure, you buy petrol [fuel], give your mate money and the police will take about 20 gh cedis [$5.00] from your out of the 50 gh cedis [$12.00] you made on a trip. How much will be left for you to make sales?" (P8)*
> "*... The police are there to enforce the law but even that when they catch you they just take money from you and let you go ..." (P20)*

2.4 Discussion

This study explored commercial drivers' perceptions of the causes of crash risks in Ghana. Similar to findings from the developed world, human factors (behaviour) were largely identified as the key risks for road traffic crashes in Ghana. Issues of working pressure, violations, concentration, training deficits, the behaviour of other road users and corruption among enforcement agencies were identified. While some of the risk factors that were reported

(e.g., fatigued driving and speeding) are similar to those identified through research in developed countries and covered by the Contextual Mediated Model (Sumer, 2003), others (e.g., beliefs) have not been widely discussed in published work relating to developed countries and may be more common to the context of developing countries.

2.4.1 Working pressure

Work pressure has been identified as a major antecedent of crashes in professional driving in the developed world (Davey, Freeman, & Wishart, 2006; Morrow & Crum, 2004). Common to the developed world, the pressure to generate revenues was reported by the Ghanaian commercial drivers. However, the outcomes of this pressure reported in Ghana were rather different from those often discussed in the literature addressing driving in developed countries. For example, the participants described competition between drivers trying to arrive first at passenger pick-up points to involve speeding, dangerous over-taking, possibly involving driving on the sidewalk and deliberate attempts to block other drivers' overtaking manoeuvres. While drivers in developed countries will experience fatigue resulting from work pressure such as engaging in long hours of work, the manifestation of fatigue in developing countries such as Ghana may be particularly extreme due to the economic pressures and lack of regulation of commercial drivers.

There are regulations that manage fatigued professional driving in developed countries. For example, EC Regulation 561/2006 and EU 165/2014 limits passenger vehicle drivers to not more than 9 hours driving and which should be interrupted by a break or breaks totalling at least 45 minutes after every 4.5 hours (Police, 2013; EU, 2006). The regulation further sets the weekly maximum limit to 56 hours driving. These limits are monitored and enforced through tachograph recordings in the EU but no similar system is in place in Ghana.

2.4.2 Violations

Driving violations are well-documented predictors of crashes in the developed world (de Winter & Dodou, 2010). Speeding and aggression, dangerous overtaking and substance use among others were reported to be common by our participants, particularly amongst young drivers. Some of the violations (e.g. speeding) are shared with developed countries. Others including poor attitude towards maintenance, unsafe loading practices may be much more common in the context of developing countries.

Other common violations reported that had unique underlying rationale included drinking and substance use. Driving under the influence of alcohol has attracted public attention in Ghana over the past two decades (Damsere-Derry, Afukaar, Palk, & King, 2014; Mock et al., 1999; NRSC, 2014) but still persists as a common driving violation. The debilitating effects of alcohol were recognised by some participants although some argued for positive influence on driving performance. There were also reports that cannabis was used by Ghanaian commercial drivers. This may result in cognitive impairments that lead to errors (Hartman & Huestis, 2013; Sewell, Poling & Sofuoglu, 2009). However, some of the participants believed that driving experience mitigates the effect of substances and this belief may further increase the risk of crashes.

The level and impact of these violations may be more severe in developing countries where legislation, monitoring and enforcement may be less effective than in developed countries. Weaknesses in policing and enforcement in Ghana was highlighted by our participants. Most strikingly, police corruption was highlighted. Corrupt practices that were mentioned included police roadblocks that could only be passed by bribery to avoid prosecution for minor infringements such as loading beyond the capacity of the vehicle. To avoid these situations, our

sample reported that commercial drivers may take unsafe alternatives routes to avoid places where corrupt policing was expected. Corruption in road traffic law enforcement may exist in developed countries but evidence of the practice predominantly comes from developing countries (Nantulya & Reich, 2002). According to their study, corruption among police and driver licencing agencies accounted for the presence of banned and improperly maintained vehicles on the roads that were increasing the crash burden in developing countries (Nantulya & Reich, 2002).

Bribery and ineffective regulation of driver licensing were also reported to encourage the entry of many untrained and inexperienced commercial drivers into the profession. Such practices allow unskilled drivers to acquire driving licenses. The participants believed that skills acquired through extensive training and experience were important for safety as a commercial driver. A body of evidence from developed countries attests to the importance of experience in road safety (McCartt et al., 2009). The problem of inexperienced drivers in the developing world may be much greater than in the developed world, if untrained drivers may access licenses through ineffective and corrupt licensing practices in countries like Ghana.

2.4.3 Social-cognitive factors

Some participants reported that they believed supernatural causes of crash were a feature of commercial drivers in Ghana. In developing countries, it has been found that fatalistic and superstitious beliefs influence driving safety behaviours such as seat belt use (Nordfjaern et al., 2014; Peltzer & Renner, 2003). In Ghana and other developing countries, such beliefs appear widespread. Kouabenan (1998) have found that culturally determined biases and beliefs affected the perception of risk and causes of accidents. These beliefs may impede efforts to

develop safer behaviours in drivers if some drivers believe that their crash involvement is not influenced by their own actions.

Efficient driving performance was also reported to be compromised by the behaviour of others. Distraction from interaction with passengers in the vehicle was noted. Our sample also indicated that the behaviour of other road users such as pedestrians, cyclists and large-bodied vehicles contributed to crash risk. To a large extent, many of the behaviours attributed to other road users were the same sorts of behaviours that our sample reported engaging in themselves this highlighted the widespread nature of the problem driving behaviour in the developing world.

The results presented here show that a number of factors identified as important crash risks in developed countries (Sumer, 2003), as discussed in Chapter One, are also salient in Ghana. Our sample identified errors and violations that were proposed to be proximal risks for driver crashes in the contextual model. Our participants also identified deficiencies in driving skills that constituted poor hazard monitoring behaviour and this is proposed to be a behavioural factor that is proximal to crashes in Sumer's model. Additionally, there were a number of factors identified in this study that constitute distal factors of crashes that supports the contextual model. For example, aggressive tendencies in driving discussed in the contextual model as constituting personality factors were identified in the present study as inimical to road safety. Our sample discussed other factors that constitute risk-taking behaviours (e.g., dangerous overtaking) that are covered under distal factors in the contextual model. Additionally, experience and age influences on crash risks were discussed by the Ghanaian sample that fit into the demographic factors proposed by the contextual model.

There was some tendency for demographic influences on the themes. For example, violations, training deficits, and inability to interpret road signs were a function of the demographics such as the age of the participant. Poor driving skills and frequent violations were attributed to young age by the elderly commercial drivers while the ability to interpret road signs was attributed to low level of formal education. This provides a hypothesis that can be tested in future quantitative studies.

There were other factors discussed by our participants that fit into the description of the other potential distal factors that were not included in Sumer's (3003) original Contextual Mediated Model but were discussed as potential additional factors in Chapter One (see Section 1.6.4). These included; low risk perception, distracted driving that constitutes safety attitudes, driver fatigue and anxiety. The data reported in this chapter therefore support the inclusion of the potential distal factors discussed (e.g., distracted driving) in the modified contextual model that may predict crash involvement directly and indirectly through proximal factors; hazard monitoring, errors and violations. This possibility will be addressed quantitatively in Chapter 4.

The original Contextual Mediated Model (Sumer, 2003) identified fatalism that relates to control beliefs held by individuals as a distal factor in crash involvement. The presentation of this issue differed in Ghana as participants offered supernatural explanations; whereas Western conceptions of fatalism broadly relate to events being determined by factors outside the individual's control, fatalistic beliefs about crash in involvement in Ghana were rooted in strong supernatural and religious beliefs. Evidence on spiritual influence on crashes is rare in Western literature (Teye-Kwadjo, 2019). The modified contextual model presented in Chapter One (see Figure 1.7) was further revised by the inclusion of fatalistic beliefs (illustrated in Chapter 4, Figure 4.1) with specific focus on external and supernatural/spiritual control of

crashes. The fatalistic beliefs are predicted to relate to crash involvement indirectly via errors and violations as such beliefs affect risk assessment and attention to driving (Kouabenan, 1998).

2.5 Limitations

The findings reported here must be interpreted in the context of some limitations. An interview approach allows unanticipated topics to be examined, which is appropriate when addressing a relatively unexplored topic. The interview approach does have weaknesses in terms of potential volunteer biases and the possibility that the participants' responses may be influenced by efforts to portray their own driving positively. One potential limitation of this study was that only English speakers took part. Exclusion of non-English speaking drivers may have led to the inclusion of more educated commercial drivers than are fully representative of the population. This concern is mitigated to some extent by our participants basing their reports on the driving behaviour that they observed in other drivers as well as on their own driving, which therefore means that the behaviour of non-English speakers has contributed to our results. Replication of the study in a non-English speaking sample of commercial drivers would be a useful goal for future research. Nonetheless our findings present a highly coherent set of results. The factors identified provide the basis for the formation of hypotheses regarding the causation of crashes in developing countries that can be explored in future research, potentially adopting a range of qualitative and quantitative methodologies.

2.6 Conclusions

In this qualitative study, we found that some of the factors identified by the commercial drivers in Ghana (e.g., risky driving style such as speeding) were similar to those covered in the Contextual Mediated Model (Sumer, 2003). However, the presentation of many of these issues

appeared more serious in the Ghanaian context. Some other factors that were identified in this study (e.g., supernatural beliefs), have not been the focus of research attention in the developed world and have not been explicitly covered by the contextual model. Revision of the contextual model therefore may be indicated by the results reported here. The overall thesis aim is to test the extent to which the revised contextual mediated model is applicable in predicting crash involvement in Ghana compared to the UK (see Chapter Four). To inform model testing, the most effective documented crash risk measure in the Western world; the Driver Behaviour Questionnaire will be examined as a potential measure of the errors and violations proximal factors specified in the contextual mediated model in a Ghanaian sample in the next chapter.

Chapter 3: Modelling Ghanaian Road Crash Risk using the Manchester Driver Behaviour Questionnaire

Abstract

In Chapter One, a model of potential behavioural risks for crash involvement was developed. In Chapter Two a qualitative study developed potential additions to the model that may improve its applicability to a Ghanaian context. Before testing the revised model quantitatively (Chapter Four), the validity of the Manchester Driver Behaviour Questionnaire (DBQ) in Ghana is tested in this chapter, so that its applicability to testing the full model can be explored. In many cultures, the Driver Behaviour Questionnaire (DBQ), which distinguishes unintentional errors (e.g., missing road signs, getting into the wrong lane) from deliberate violations (e.g., speeding, crossing red lights) has been demonstrated to be an effective measure of crash liability. The original DBQ developed by Reason et al. (1990) has been adapted and used in more than 150 countries, mostly in the Western world. The DBQ has been less often used in other settings such as Africa where the highest rates of road crashes are experienced.

The present study examines the performance of the DBQ in a sample of 453 Ghanaian drivers. In a random half of the data set, exploratory factor analysis was used to construct a factor model of the DBQ. The effectiveness of the constructed model was cross-validated with the other half of the data set using confirmatory factor analysis. The analyses produced a 24 item 2-factor (violations and errors) model of the DBQ. As evidence of the external validity, both violations and errors were independently correlated with self-reported crash involvement and were moderately correlated with sensation seeking. Higher levels of violations and errors were reported by the Ghanaian sample than typically observed in the UK. While the Ghanaian DBQ shows a different factor structure from research conducted in the developed world, the findings

support the usefulness of the measure in characterising the behaviours underlying crash risk in Ghana and indicate that it is a suitable instrument to measure to include in the assessment of proximal factors in the revised contextual mediated model that is being developed in this thesis.

3.1 Introduction

As discussed in Chapter 1, the Driver Behaviour Questionnaire (DBQ) (Reason et al., 1990) is a well-documented measure of risky driving in the developed world (de-Winter & Dodou, 2010; de Winter, Dodou, & Stanton, 2015) but has been less often used in the Global South, particularly in the low-middle-income countries of Africa like Ghana. In order to determine whether the DBQ is suitable to include in the empirical test of the contextual mediated model, planned for Chapter 4, it is necessary to establish whether the DBQ works similarly in Ghana, in terms of having similar factor structure and external correlates. The most crucial categorisation of risky driving behaviours made in the DBQ is between violations and errors as forms of aberrant driving behaviours that have different psychological origins (Reason et al., 1990). Violations constitute 'acts that contravene safe driving practices (e.g., disregard the speed limit on a motorway) while errors represent the failure of planned action to achieve their intended consequences' (e.g., underestimate the speed of an oncoming vehicle when overtaking) (Reason et al., 1990, p. 1316).

Violations can be sub-divided into ordinary and aggressive violations (Lawton et al., 1997). Ordinary violations include deliberately engaging in behaviours that deviate from accepted safe driving conventions without specific aggressive intent (e.g., 'disregard the speed limit on a residential road'). Aggressive violations involve violations that reflect interpersonally aggressive traits (e.g., 'become angered by another driver and give chase with the intention of giving him/her a piece of your mind'). Errors may also be subdivided, with slips/lapses, defined as memory failures (e.g., 'get into the wrong lane approaching a roundabout or a junction'), seen as a distinct subset (Reason et al., 1990, p. 1316). However, these sub-divisions are much less fundamental than the distinction between violations and errors (de-Winter & Dodou, 2010).

While maintaining the distinction between violations and errors, many published studies use different versions of the DBQ in terms of the number and nature of the items presented and the scales formed from them. For example, the literature contains a 24-item 3-factor solution specifying violations, errors and lapses (Aberg & Rimmo, 1998; Parker et al., 1995b); a 28-item 4-factor solution that comprises ordinary violation, aggressive violations, errors and lapses (Mattsson, 2012); and a 27-item version (Harrison, 2009; Lajunen et al., 2004; Lajunen & Summala, 2003) that has a similar factor solution to the 28 item version but does not include an item addressing drink-driving.

External validity of the DBQ has been demonstrated by studies showing that the subscales correlate with driving performance measures. de Winter (2013) showed that self-reported violations correlate with violations and speeding in a driving simulator. Helman and Reed (2015) also found that the DBQ violations scale correlated with objectively measured speed in an instrumented vehicle and in a driving simulator (r =.38 in two reported studies). In terms of association with real-world behaviour, dangerous violations [a sub-set of violations described as dangerous by Helman and Reed (2015)] have been found to correlate positively with traffic citations (Blockley & Hartley, 1995). A crucial test for a behavioural measure of risky driving is to measure crash liability. However, violation- and error-prone driving does not always result in crashes as the road environment can be forgiving to driving of this sort. Furthermore, crashes are relatively rare and can occur through no fault of one driver but as the result of someone else's error or violation, making crashes a challenging correlate to statistically identify. Therefore, behavioural risk factors are likely to only weakly correlate with crash involvement. However, significant positive correlations have been found between DBQ errors and violations and crash involvement in a meta-analytic review (de Winter et al., 2015). Violations (r=.13)

based on 57,480 participants from 67 samples and errors (r=.09) based on 66,028 participants from 56 samples were correlated with self-reported crash involvement.

Further evidence of the external validity of the DBQ has been provided by studies linking DBQ scores to demographic and personality factors, many of which are linked to crash involvement. The evidence shows that males report more violations while females report more errors (e.g., de Winter & Dodou, 2010, 2016). A positive relationship has been found between driver's age and driving errors, as younger drivers reported more violations than older drivers (Cordazzo et al., 2014; de Winter & Dodou, 2010). Higher mileage was positively associated with violations (de Winter & Dodou, 2010). Sensation seeking, 'the need for varied, novel, and complex sensations and experiences and the willingness to take physical and social risks for the sake of such experiences' (Zuckerman, 1979: 10), has also been found to correlate with violations (Mallia et al., 2015).

Alternative forms of the DBQ scale have been validated in different cultures across Europe, Asia and the Americas. Examples include: Sweden (Aberg & Rimmo, 1998), Turkey (Sumer, 2003), China (Qu et al., 2016; Yang et al., 2013, Zhang et al., 2016), New Zealand (Sullman, Meadows, & Pajo, 2002), Greece (Kontogiannis, Kossiavelou, & Marmaras, 2002) and Finland and the Netherlands (Lajunen et al., 1998; Mesken, Lajunen, & Summala, 2002). The major distinction between violations and errors has been maintained across cultures, but subtle differences have been observed in terms of the number of factors extracted and the loadings of items onto factors. To some extent, these differences may be due to the application of different versions of the DBQ and differences in sampling approach (Ozkan et al., 2006). Differences in societal norms and rules may also influence the relationship between underlying psychological processes and manifesting risky driving behaviours (Bjorklund, 2005) and therefore influence

the pattern of factor loadings. For example, the item for drinking under the influence of alcohol does not load on any factor in some cultures (Lajunen et al, 2004; Nordfjærn et al., 2014) but loads onto the ordinary violation factor among a Finnish driving sample (Mattsson, 2012). It may be that these differences result from cultural differences in the extent to which drink-driving involves violating culture specific accepted safe driving principles. It is also possible that there are cultural differences in the interpretation of the behaviours measured in the DBQ (Stephens & Fitzharris, 2016).

Ozkan et al. (2006) found satisfactory fit for a 3-factor DBQ structure (violations, errors, and lapses) across six countries (Finland, Great Britain, Greece, Iran, The Netherlands, and Turkey). However, Ozkan et al. did find differences in the frequency of violations and errors between different cultures. For instance, aggressive violations such as indicating annoyance and hostility to other road users were more common among Greek drivers than Dutch and Finnish drivers while the later reported more ordinary violations (e.g., speeding on a motorway) (Ozkan et al., 2006). Regarding errors, drivers from South-eastern European countries (e.g., Greece and Turkey) reported more errors than those from North-Western European countries (e.g., UK and Finland).

The present study explores whether the DBQ is a useful measure of risky driving behaviours in Ghana. The exploratory qualitative study reported in Chapter Two (Dotse, Nicolson & Rowe, 2018) provided some basis for expecting that the DBQ may be a useful measure in this context. For example, risky driving behaviours of the sort measured in the DBQ, such as speeding, disregarding traffic signals and dangerous overtaking were reported to be common in Ghana and plausibly associated with similar characteristics as identified in the Western world such as being younger, male and high in sensation seeking. However, Dotse et al. also found evidence

that there may be differences involved in the psychological processes underlying some driving behaviours between Ghana and the Western world. For instance, there was evidence of substantial training deficits, partly as a result of licences being obtained through bribery. There was also evidence of extremely risky driving practices in commercial drivers including very risky behaviours like racing other drivers to passenger pick-up points. Road crashes were also partly attributed to spiritual influences. The importance of factors of this sort in Ghana may mean that the DBQ provides a less comprehensive assessment of risky driving behaviours in Ghana than it does in other countries.

We tested the factor structure of the DBQ in a Ghanaian sample using a combination of exploratory and confirmatory approaches. External validity was assessed by examining the correlates of the extracted factors with measures documented to correlate with the DBQ in the Western literature. These included demographic characteristics, sensation seeking, self-reported crash involvement and traffic citations. On the basis of literature from the developed world, it was predicted that violations would relate to crash involvement and citations, younger age, being male and sensation seeking. Errors were predicted to relate to crash involvement, being female, and older age but not to traffic citations or sensation seeking. Additionally, both violations and errors were predicted to relate to higher mileage. We also compared the level of risky driving behaviour reported in Ghana with UK levels as reported in a study that DBQ in a medium sized sample of UK drivers (Lajunen et al., 2004). We expected that levels of aberrant driving would be higher in Ghana, because crashes are more common there than in the UK.

3.2 Method

3.2.1 Sample

Data were collected by a team of research assistants from the Department of Psychology, University of Ghana. Initial contacts were made with the individual participants through personal approaches and mutual acquaintances. Commercial drivers were approached at various lorry parks and stations within Accra where they loaded and discharged passengers. Other categories of drivers were approached in the premises of public and private organisations (e.g., University of Ghana and the Very Important Person bus depot). Participants provided informed consent. Ethical approval was obtained from The Department of Psychology Ethics Committee at University of Sheffield (UK) and University of Ghana Ethics Committee for the Humanities. Participants were paid GHS 15.00 (£3) for expenses.

Five hundred questionnaires were distributed and 453 were returned completed (90.6%). There was occasional missing demographic data but all the DBQ, sensation-seeking and self-reported crashes items were fully completed. All participants were proficient in English and had at least basic formal education (Primary School). In Ghana, adult English literacy (reading and writing) rate was 77% in 2017 (WHO, 2018). Type of vehicles usually driven by the participant were 101 (22.29%) private vehicles (saloon and cross country vehicles), 96 (21.19 %) cross country vehicles and busses that belonged to organisations, 189 (41.72%) were commercial passenger vehicles (taxi cabs; 27, minibuses /trucks & vans; 65, lightweight buses; 59, and big bus/coach; 38) and 67 (14.79) were goods trucks and heavy machinery (e.g., articulated truck, and tractors). Classes of license held included *'B'* (cars and cross-country vehicles not exceeding 3000kg)*;* 25.3%, '*C'* (goods carrying vehicles, buses/coaches of between 3000-5500kg or 1-33passengers)*;* 40.2%, '*D'* (goods carrying vehicles, buses/coaches not exceeding 8000kg)*;* 28.7%, '*E'* (graders, loaders, forklifts, tractors, bulldozers, dumpers and rollers)*;*

2.7%, and '*F'* (goods carrying vehicles, buses/coaches and articulator vehicles over 8000kg)*;* 3.1%. None held *'A'* for mopeds with or without sidecars weighing 50-250cc and above.

All participants had driven in the previous 6 months and all reported that they drove on all or most of the days in a week. The majority held full licences (96.9%). Eleven held provisional licences (2.4%) that allow independent driving in Ghana. Three (0.7%) indicated that they did not hold a licence and were therefore driving illegally. The sample was predominantly male (77.5%) and was aged between 21 and 67 years (*M* = 40.93, *SD* = 9.93). Their driving experience was 1- 43 years (*M* = 9.53, *SD* = 7.14). Participants reported weekly mileage of 2 - 686 km (*M* = 102.22, *SD* = 118.72). A total of 152 (33.6%) reported being involved in a crash as a driver during their driving careers. Of these, 115 (75.66%) had crashed once, 31 (20.40%) had crashed twice and 6 (3.94%) had crashed three times. Within the 12 months prior to data collection, 35 (7.7%) indicated being cited for traffic offences, 13 (2.9%) were cited twice and 1 (0.2%) had three convictions. The UK sample for the original study (Lajunen et al., 2004), reported; age (*M* = 39.55, *SD* = 14.51), driving experience in years (*M* = 18.35, *SD* = 12.91), annual mileage (*M* = 18612, *SD* = 20894). The participants were 51.3% males. The minority (31.3%) were involved in a crash in the previous 3 years.

3.2.2 Measures

We used the Manchester Driver Behaviour Questionnaire that comprised 27 items (Lajunen et al., 2004) with an additional 'drink and drive' item taken from Mattsson (2012). Typical results from testing the factorial structure of Manchester Driver Behaviour Questionnaire from developed countries distinguish ordinary violations (8 items, e.g., overtake a slow driver on the inside), aggressive violations (3 items, e.g., sound your horn to indicate your annoyance to another road user), errors (8 items, e.g., failed to check rear-view mirror before pulling out or

changing lanes, etc.) and lapses (8 items, e.g., get into the wrong lane approaching roundabout or a junction) (Lajunen et al., 2004). This version of the DBQ has been subjected to robust factorial invariance testing by a number of researchers (e.g., Mattsson, 2012; Stanojević, Lajunen, Jovanović, Sârbescu, & Kostadinov, 2018). The drink and drive item has been found to load onto the ordinary violation component (Mattsson, 2012). Respondents indicate how often they engage in each of the behaviours on a six-point Likert scale (never = 0, hardly ever = 1, occasionally = 2, quite often = 3, frequently = 4, nearly all the time = 5). Minor changes were made to three DBQ items to recognise that drivers drive on the right in Ghana. Crash involvement (crash resulting in injury, death or damage to property and which involve at least one vehicle) 'while you were driving' was measured through self-report as in previous studies (Iverson & Rudmo, 2004; Ulleberg & Rudmo, 2003).

Sensation seeking was assessed using the 8 item Brief Sensation-Seeking Scale (Hoyle Stephenson, Palmgreen, Lorch, & Donohew, 2002**)** which measures experience seeking (e.g., I like to explore strange places), boredom susceptibility (e.g., I get restless when I spend too much time at home), thrill and adventure seeking (e.g., I like to do frightening things) and disinhibition (e.g., I would love to have new and exciting experiences even if they are illegal). The items were answered on a five-point Likert scale ranging from 'strongly disagree' to 'strongly agree'. The items form a unidimensional scale where high scores indicate high sensation seeking. Iversen and Rundmo (2002) reported a Cronbach Alpha of .82 for the scale.

3.2.3 Analytic Strategy

To examine the DBQ factor structure, the data was split into two random halves. One half (228 observations) was used for model building using Exploratory Factor Analysis (EFA). Confirmatory Factor Analysis (CFA) was conducted with the second half of the data (225

observations) to cross-validate the model identified through EFA in an independent dataset (Byrne, 2013). The EFA was conducted using SPSS (IBM Corp, 2011). Principal axis factoring with oblique rotation was employed given that DBQ factors are usually correlated (de Winter et al., 2010). The CFA models were estimated using WLSMV-estimator (Weighted Least Squares with Mean and Variance correction) in Mplus 7.11 (Muthen & Muthen, 2012) with responses treated as ordinal. The adequacy of models was assessed using three fit indices; Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI). Values of RMSEA; ≤ .08, CFI and TLI; ≥ .90 indicate adequate model fit (Hu & Bentler, 1999) while RMSEA; ≤ .06, with CFI and TLI; ≥ .95 indicate excellent model fit (Bentler, 1990). To test the external validity of the DBQ, we calculated Pearson correlations between the extracted DBQ factors, sensation seeking, age, sex, experience and mileage using the full sample of 453 observations. Logistic regression was used to test the association between the dimensions of the DBQ and crash involvement (involved vs not involved). The levels of reported errors and violations between Ghana and data from the UK reported by Lajunen et al. (2004) were compared with the immediate form of the t-test in Stata (Stata Corp, 2013).

3.3 Results

3.3.1 Exploratory Factor Analysis (EFA)

Prior to EFA using the first random half of the data, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The factorability of the correlation matrix was supported by a Kaiser-Meyer-Oklin measure of sampling adequacy of .82, meeting the commonly recommended value of .6 and above (Kaiser, 1970, 1974) and the significance of Barlett's Test of Sphericity (Bartlett, 1954) (χ^2 (378) = 5.68, $p < .001$). The initial EFA identified seven components with eigenvalue

exceeding 1, explaining a total of 77.43% of the variance. The scree plot (Appendix B1) revealed a clear break (elbow) after the second component. Therefore, two components were retained for further analysis.

Following oblique rotation the extracted factors were substantially correlated (r=.70). The two-factor solution explained 51.7% of the variance, with component one contributing 32.5% and component two contributing 19.2%. The pattern of loadings (Table 3.1) shows that the majority of the violation items (aggressive violations [AV] and ordinary violations [OV] items) had their highest factor loadings on a 'violations' factor. However, five error items (*E1, E2, E3, E4 and E5* and one lapse item (*L1*) also loaded onto this factor. The second factor; errors combined the rest of the items from the errors and lapses sub-scales in addition to one violation item regarding overtaking on the inside (*OV8*). Four items (E8, L7, L8 and OV9) which had loadings below .50 on both factors and were dropped.

Table 3.1 Descriptive statistics of the Driver Behaviour Questionnaire DBQ items in Ghana and UK, and Exploratory and Confirmatory Factor Loadings for the Two-Factor Solution in Ghana

	Item	**EFA (GH)**		**CFA (GH)**	**GH (n = 453)**		**UK (n = 831)**		**GH vs UK Effect size**
		Viol	Error/ Lapses		Mean	SD	Mean	SD	
AV1	Become angered by another driver and give chase with the intention of giving him/her a piece of your mind.	.85		.82	1.53	1.26	.20	.59	1.35***
OV1	Race away from traffic lights with the intention of beating the driver next to you	.78		.82	1.21	1.30	.99	1.15	.18**
E1	Attempt to overtake someone that you had not noticed to be signalling a left turn	.75		.83	1.26	1.09	.24	.47	1.26***
OV2	Disregard the speed limit on a motorway	.75		.93	1.76	1.26	1.87	1.61	.08
AV2	Become angered by a certain type of a driver and indicate your hostility by whatever means you can	.74		.80	1.73	1.31	.85	.96	.77***
OV3	Disregard the speed limit on a residential road	.73		.83	1.45	1.33	1.38	1.21	.08
AV3	Sound your horn to indicate your annoyance to another road user	.73		.52	2.11	1.13	1.06	1.08	.95***
OV4	Cross a junction knowing that the traffic lights have already turned against you	.70		.75	1.27	1.13	.78	.84	.49***
L1	Attempt to drive away from the traffic lights in third gear	.69		.78	1.06	1.12	.69	.86	.37***
OV5	Drive so close to the car in front that it would be difficult to stop in an emergency	.69		.85	1.23	1.17	.80	.86	.42***
OV6	Pull out of a junction so far that the driver with right of way has to stop and let you out	.66		.73	1.17	1.03	.82	.99	.35***
OV7	Stay in a motorway lane that you know will be closed ahead until the last minute before forcing your way into the other lane	.59		.81	1.11	1.09	.52	.85	.60***
E2	Underestimate the speed of an oncoming vehicle when overtaking	.58		.83	1.49	1.19	.74	.70	.79***
E3	Brake too quickly on a slippery road or steer the wrong way in a skid	.56		.71	.87	1.02	.68	.70	.22***
E4	Miss “Give Way” signs and narrowly avoid colliding with traffic having right of way	.55		.72	.98	.96	.24	.47	.98***
E5	Fail to check your rear-view mirror before pulling out, changing lanes, etc	.54		.74	1.34	1.26	.71	.82	.60***
L2	Realise that you have no clear recollection of the road along which you have just been travelling		.72	.63	1.18	.97	1.17	1.03	.01
L3	Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers		.66	.84	1.19	1.22	.89	.89	.28***
E6	Fail to notice that pedestrians are crossing when turning into a side street from the main road		.61	.79	1.13	1.02	.44	.61	.82***
L4	Misread the signs and exit from a roundabout on the wrong road		.61	.86	.81	.96	1.03	.78	-.25***
L5	Forget where you left your car in a car park		.59	.63	.72	.92	1.16	1.09	-.44***
OV8	Overtake a slow driver on the inside		.56	.62	1.36	1.16	.70	.95	.62***
E7	On turning left nearly hit a cyclist who has come up on your inside		.56	.68	.79	.86	.31	.55	.66***
L6	Get into the wrong lane approaching a roundabout or a junction		.53	.65	.85	.86	1.45	.82	-.71***
E8	Queuing to turn right onto a main road, you pay such close attention to the mainstream of traffic that you nearly hit the car in front				1.11	1.11	.63	.71	1.02***
L7	Hit something when reversing that you had not previously seen				.52	.68	.45	.62	.11*
L8	Intending to drive to destination A, you ‘wake up’ to find yourself on the road to destination ‘B’.				.51	.81	.86	.92	-.39***
OV9	Drink and drive				.62	.91	-	-	-

EFA - Exploratory Factor Analyses (only loadings > .50 were shown), CFA = Confirmatory Factor Analyses
AV- aggressive violation, OV – ordinary violation, E – error and L – lapse
CFA loads AV2-E3 on a violations factor and L9 to L4 onto an errors factor
**** p < .001*
*** p < .01*
** p <.05*

3.3.2 Confirmatory Factor Analysis (CFA)

Confirmatory Factor Analysis was conducted on the second random half of the data to cross-validate the model identified from the EFA in an independent set of observations. Model fitting was confined to the 24 items that were included in the final EFA model. As shown in Table 2, the fit of this 2-factor model (violations and errors) was assessed against other plausible competing factor structures.

Table 3.2 Model fit statistics for the one and two-factor models of the DBQ in Ghana. The preferred model is highlighted in bold

Model	χ^2	***RMSEA***	***CFI***	***TLI***
1 Aberrant driving (single factor)	1460.24	.18	.94	.93
2 Violations & errors	**1357.56**	**.10**	**.97**	**.96**
3 Violations, errors, & lapses	1691.37	.11	.94	.93
4 Ordinary viol, aggressive viol, errors, & lapses	1794.40	.18	.84	.83

All χ^2 are significant at p<.001 on df = 349

Table 3.2 shows that a 4-factor model (ordinary and aggressive violations, errors and lapses) had poor fit according to all indices. A one-factor model showed a poor RMSEA but had adequate fit according to CFI and TLI. A 3-factor model (violations, errors and lapses) showed a better RMSEA but the 2-factor model showed better fit in terms of CFI, TLI and RMSEA. The RMSEA values for the 2-factor model exceeded the recommended cut-off (.08). However, the fit was acceptable across the range of indices and therefore the 2-factor model was selected as most appropriate. Table 1 shows that the factor loadings from the 2-factor model are all significant and of comparable magnitude to the EFA. The 2-factor solution forms the basis of further analyses.

3.3.3 Reliability and the relationship among the study variables

Using the full dataset, scales for violations and errors in Ghana were calculated by totalling the items identified to load strongly onto each factor. The violations, errors and the sensation seeking scales showed acceptable reliabilities; violations ($\alpha = .95$), errors ($\alpha = .86$), sensation seeking ($\alpha = .79$). A computed generalised Cook's distance statistic (*gCD*) (Bollen & Jackman, 1990) for each of the variables revealed no outliers. As shown in Table 3, there were significant positive correlations between violations, errors and sensation seeking. A test of difference showed that sensation seeking was significantly more strongly related to errors than violations (z = 4.08, $p < .001$; Lee, & Preacher, 2013). Table 3.3 also shows sex was significantly correlated with violations with males scoring higher than females. There was no significant correlation between sex and errors. Similarly, higher mileage related significantly to violations but not errors. Significant positive relationship was found between self-reported traffic citations over the last 12 months and violations but not errors. Finally, both the violations ($r = .31$, 95% Bias-corrected Bootstrap Confidence Interval [BCa CI] = .23-.40) and errors ($r = .28$, 95% BCa CI = .19-.37) related positively with crash involvement, with no significant difference between these correlations (z = .49, $p = .62$).

Table 3.3 Correlations among study variables (n =453)

	1	*2*	*3*	*4*
1. Violations	-			
2. Errors	.34**	-		
3. Sensation seeking	.42**	.62**	-	
4. Crash Involv.	.31**	.28**	.03	-
5. Age	.08	.06	.01	.14**
6. Sex	.11*	.03	.01	.16**
7. Experience	.08	.03	.01	.13**
8. Mileage	17**	.06	.06	.28**
9. Traffic citation	.10*	.09	.08	.16**

*** p<.01 (2-tailed),*
** p<0.05 level (2-tailed),*
Sex (female = 0, male = 1)

3.3.4 Association of the DBQ factors with crash involvement

We investigated the potential role for confounding variables in the associations between the DBQ factors (violations and errors) with self-reported crash involvement using logistic regression. Age, sex, mileage, and experience (years driving) were treated as covariates in the model. All continuous predictors were standardised (z-scores) so that associations are presented as the odds ratios for a 1 standard deviation increase. To determine whether the socio-demographic variables were associated with crashes independently from errors and violations, a formal hierarchical approach was adopted. The socio-demographic variables were entered at the first step and the errors and violations entered at the second step.

Table 3.4 Logistic regression model of the association between violations, errors and crash involvement

	Odds ratio (95% Confidence Interval)	
Variable	Step 1	Step 2
Age	1.35* (1.02-1.79)	1.29 (.96-1.75)
Sex	1.60 (.91-2.83)	1.54 (.85-2.80)
Experience	.91(.67-1.21)	.92 (.68-1.24)
Mileage	1.65*** (1.31-2.08)	1.57*** (1.24-2.00)
Violations		1.62*** (1.29-2.03)
Errors		1.61***(1.28-2.02)

** p < .05*
*** p < .01*
**** p < .001*
Sex (female = 0, male = 1)

As shown in Table 3.4, age and mileage significantly predicted crash involvement at step 1 while sex and experience did not. At step 2 violations and errors were independently significant additions to the model predicting crash involvement. Mileage remained a significant predictor and age was no longer significant.

3.3.5 The level of aberrant driving in Ghana compared to UK

Given factors structures differ in Ghana and UK, the cross-cultural comparison was made at the item level. The drink-drive item was omitted as it was not measured in the UK sample (Lajunen et al., 2004). As shown in Table 1, 20 items were reported to be more frequent by Ghanaian drivers than UK drivers with effect sizes ranging from .11 to 1.35. No significant difference was found for 3 items (OV2, OV3; that concern disregarding speed limits and L2; have no clear recollection of the road along which you have just been travelling). Four lapses items in the UK (L4, L5, L6, and L8) were rated more common in the UK than in Ghana with effect sizes ranging from .25 to .71.

3.4 Discussion

The 28 item DBQ is a well-used predictor of crashes in the Western world. The present study addressed the validity of the DBQ in Ghana – the first study to do this to our knowledge. A two-factor structure was observed with item loading patterns that differed from the violations and errors distinction found for many other settings (e.g., Ozkan et al., 2006). The resulting errors and violation scales showed a number of expected correlations with demographic variables, driving experience, sensation seeking and crash involvement, supporting their external validity. The subtler distinctions between aggressive and ordinary violations and between errors and lapses that have often been reported in studies using the DBQ in the Western world (e.g., Lajunen et al., 2004) were not found in Ghana.

The errors and violations factors derived in the present study were based on 24 items and differed from the composition of the original 28 item version (Lajunen et al., 2004). The possibility of some differences was expected given the outcome of the prior explorative study (Chapter 2, Dotse et al., 2018) that hinted at differences in the psychological processes

underlying some driving behaviours between Ghana and the Western world. The violation component was made up of 16 items that comprised 10 of the 12 items designed to measure violations from the original 28 item version, as well as 6 error items. The 6 error items could be deliberate violations in Ghana. For example, overtaking a left-turner (see E1, Table 1) could be a deliberate method of dangerous overtaking in Ghana. To underestimate the speed of oncoming traffic when overtaking (E2, Table 1) could be a sign of a driver who does a lot of dangerous overtaking (i.e., a high violator) that puts them in danger of making this error. Braking too hard (E3, Table 1) could also be a sign of driving too fast and not checking mirrors (E5, Table 1) could also be a sign of recklessness that defines violations.

The drink-driving item (OV9, Table 1) was expected to load onto the violations factor but it did not. It has been found elsewhere that this item does not always load onto the violations factor (Lajunen et al., 2004). This suggests that drink-driving is independent of general risky driving in some cultures including Ghana. Even though drink-driving is illegal in Ghana (Road Traffic Act 683 of 2004) not all drivers consider that alcohol increases driving risk (Dotse et al., 2018). Therefore this might explain why drink-driving does not correlate with other risky driving items in Ghana.

The second component (errors) that was made up of 8 items was composed mainly of error and lapse items as well as one violation (overtaking a driver in the inside lane). In the UK this item would usually involve a driver on a motorway becoming frustrated when obstructed by a car in their lane and opting to overtake them in an illegal manner. It may be that Ghanaian may drive passed cars in an inappropriate lane unintentionally rather than as a deliberate violation of safe practices or might not know that undertaking is against the road rules. There were other behaviours (e.g., nearly hitting a car in front as a result of paying attention to mainstream

traffic, hitting something when reversing and selecting the road to the wrong destination) that were endorsed regularly but they do not clearly load onto the violations or errors factor in our Ghanaian sample.

We found the errors and violations scales identified in Ghana had many similar external correlates to those observed in the developed world. As expected (de Winter & Dodou, 2010), violations were reported more commonly amongst males than females. We found no sex difference in the reporting of errors contrary to our expectation that these might be more common in females (de Winter & Dodou, 2010; Reason et al., 1990). Non-significant relationships were found between age and violations as well as with errors. The non-significant relationship between age and errors was expected based on existing literature (Aberg & Rimmo, 1998; de Winter & Dodou, 2010). In contrast, existing findings indicate the young reporting more violations (e.g., de Winter & Dodou, 2010; Ozkan et al., 2006). The discrepancy might be explained by the age distribution of the samples involved. In the developed world the biggest age differences have been found in the teen and early 20s drivers (e.g., Mallia et al., 2015) but the present sample does not include many young people. Reported daily mileage was positively associated with violations but not errors as found in the developed world (de Winter & Dodou, 2010). We also found the expected correlation between violations and traffic citations.

The expected relationship between sensation seeking and violations was identified. This is likely to reflect high sensation-seekers being more likely to choose driving styles with higher frequencies of violations (Mallia et al., 2015). In addition, we found that errors were associated with sensation-seeking independently from violations and, indeed sensation-seeking was correlated significantly more strongly with errors than violations. This finding was unexpected

on the basis of findings from the developed world (e.g., Rimmo & Aberg, 1999). It is possible that an error prone style of driving in Ghana is more representative of an emotionally involved driving style leading to distraction rather than being based on cognitive limitations as in the developed world.

The DBQ was designed to measure the behavioural contribution to crash risk. Therefore, a crucial test of validity is the correlation of the DBQ scales with crash involvement, particularly with regard to inclusion in the test of the revised Contextual Mediated Model in subsequent study. Replicating findings from the developed world (de Winter & Dodou, 2010; de Winter et al., 2015), we found significant independent relationships of errors and violations with crash involvement. In our Ghanaian sample, the simple correlations of violations (r = .31, 95% CI = .23-.40) and errors (r = .28, 95% CI = .19-.37) with crash involvement were substantially higher than reported in De Winter et al.'s (2015) meta-analysis which largely includes studies from the developed world (violations: r = .13, 95% CI = .12-.13 and errors r = .09, 95% CI =.08-.09). It is not clear why the observed correlation between DBQ scales and crashes should be higher in Ghana than elsewhere. One possibility is that the relatively less regulated road context of Ghana provides fewer structures to mitigate the translation of risky driving tendencies to road traffic crash involvement.

Higher levels of aberrant driving were reported in Ghana than typically found in Western samples such as the UK sample reported by Lajunen et al. (2004), particularly regarding violations. The pattern was more mixed regarding errors with some items reported to be more common in the UK and some reported more frequently in Ghana. There are a number of possible explanations for these findings, including that the response scale may be interpreted differently in Ghana and/or that the sample selected here may be unrepresentative of the

Ghanaian driving population. However, an alternative possibility is that rates of aberrant driving and particularly violations may be genuinely higher in Ghana. This may contribute to the greater risk of crashes in Ghana compared to the developed world. Further research will be required to test this possibility and the issue is explored in more detail in Chapter 4.

3.5 Limitations

Our volunteer sample may not be fully representative of the Ghanaian driving population. However, we had a good range of drivers in terms of experience, education and socio-economic background whose responses constituted a coherent set of results. The exclusion of non-English speaking drivers may have led to the inclusion of more educated drivers than are fully representative of the population. The inclusion of illiterate participants (adult literacy rate in Ghana is 77% [World Bank, 2015]) will be a challenge for future driving research in Ghana. The data for the study was based solely on self-reports and therefore the relationships observed may be inflated by common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). However, Lajunen and Summala (2003) concluded that common method variance in the DBQ responses is generally very small. Other researchers (e.g., McDonald, Ingham, Hall, & Rolls, 1991; McGwin, Owsley, & Ball, 1998) found moderate agreement between self-reported and objective (state-recorded) crash measures. Strong correlations between self-reported and observed behaviour have been found suggesting self-report measures are an effective surrogate for observed behaviour (Elliott et al., 2007). This supports previous evidence of a strong relationship between externally observed speed and self-reported speed (Haglund & Åberg, 2000). Further work validating the DBQ with objective crash measures in the Global South and with a larger sample would be advantageous.

The study reported here was based solely on cross-sectional data and may impact directionality; being involved in a crash could change driving behaviour. In comparison, similar studies (e.g., Rowe et al., 2015) based their conclusion on the validity of the DBQ on longitudinal data (Cohort II) that might be more useful in identifying the future outcomes of DBQ scores. However, the use of the cross-sectional data yielded results that are useful in both developed and Global South contexts. The use of longitudinal data on the DBQ in future studies in low and middle-income countries may be advantageous.

3.6 Conclusion

We found that the DBQ was a useful measure to characterise drivers' behavioural contribution to crash risk in Ghana. The error/violation distinction that is a central characteristic of the DBQ approach to classifying aberrant driving behaviour remained salient in this context. This indicates that the DBQ is a useful tool for road safety research in Ghana, including testing the Contextual Mediated Model in the study reported in Chapter 4. Higher levels of errors and violations were reported in Ghana compared to other developed settings, underscoring the need for more controls on aberrant driving in Ghana. Notwithstanding, care needs to be taken when applying the DBQ in the Global South because the factor structure differs from the Western world. The extent to which the present findings generalize to other developing settings should be investigated in future studies.

Chapter 4: Behavioural Predictors of Road Crash Risks: A comparison of Ghanaian and UK drivers

Abstract

This thesis has developed a model of behavioural risk factors for road traffic crash based on a literature review (Chapter One) and a qualitative study of commercial drivers in Ghana (Chapter Two). The model posits that distal factors such as personality and fatalistic beliefs increase crash risk both directly and via proximal factors including errors, violations and hazard monitoring. Chapter Three demonstrated that the Manchester Driver Behaviour Questionnaire was an appropriate tool to measure errors and violations in Ghana. This study applies the developed contextual mediated model to a sample of 478 Ghanaian motorists. The model was also applied to a comparison sample of 404 UK drivers to examine the extent to which the processes underlying crash risk as identified in Ghana are culturally-specific. Path modelling results show that distal factors predicted crash involvement directly and indirectly through crash risks in both Ghana and the UK. Ghanaian drivers reported higher errors and violations scores compared to the UK sample that could be attributed to the effects of factors; anxiety, fatalistic beliefs and distraction. The findings provide empirical support for the revised contextual mediated model to explain driving behaviour in Ghana as well as the UK.

4.1 Introduction

As indicated in Chapter One, empirical evidence mostly from the Western world has identified human behaviour as the major contributory factor (95%, Petridou & Moustaki, 2000) to driver crashes. The behaviours identified to increase crash liability include risk taking, violations of traffic safety regulations and those that relate to human performance limitations; errors and lapses (de Winter & Dodou, 2010). The contextual mediated model (Sumer, 2003) distinguishes between distal factors and proximal factors that increase crash liability. If models of crash risk can be applied and modified to low and middle income countries then they can inform policy based prevention and training in the Global South and help to reduce the heavy public health burden of road crashes in these areas. However, the applicability of some of the models to the Global South settings requires further exploration as they may not be universal to all cultures. As noted in Chapter Two, it is possible that there are psychological factors that are important to crash risk in the Global South (e.g. supernatural beliefs and corruption) which have been less frequently studied in the Western literature. The context of the Global South may also alter the level at which the antecedents of risky driving are present in comparison to the developed world and there may be variations in the extent to which structures are in place to control dangerous practices. For example, commercial pressures on professional drivers may be stronger in the Global South leading to speeding to meet revenue targets, and the legal enforcement of driving laws may be less rigidly applied to mitigate the pressures to violate driving rules.

This study aimed to model the processes underlying risky driving behaviours in Ghana and compare them to the processes underlying risky driving in the UK. This will help determine the extent to which driver crash prediction models from the Western world generalises to low and middle income countries contexts such as Ghana. The design of this quantitative study was

informed by the findings of the previous three chapters. Chapter One contributed to the choice of measures, in terms of identifying the best predictors of crash risk in developed countries available in the existing literature. This was summarised in terms of a revised Sumer model. Factors not explicitly discussed in Sumer's model: safety attitudes (e.g., risk perception) cognitive factors (e.g., distraction) and psychosocial factors (e.g., driver stress and fatigue) and anxiety were added to the revised model on the bases of literature reviewed from the Western world. The qualitative study reported in Chapter Two also contributed to identifying potential predictor variables that may be specific to the Ghanaian context; fatalistic beliefs and therefore less prominent in literature addressing crashes in the developed world. A minor revision was therefore made to the Contextual Mediated Model (Sumer, 2003) again on the basis of the results from Chapter Two. Chapter Three contributed in terms of showing that the DBQ is an effective measure the proximal behavioural crash risk behaviours of errors and violations in Ghana. To provide an explicit comparison to the predictors of crash risk in the developed world, we also explored the fit of a similar model to a sample of UK drivers who had completed the same set of measures.

4.1.1 Revised Contextual Mediated Model

As highlighted earlier context specific factors of crash risks in the Global South may limit the applicability of the original contextual mediated model (Sumer, 2003; see Section 1.7.1, p.16 of Chapter One for coverage). The revised model, based on existing Western literature and supported by our qualitative data (Chapter Two) as shown in Figure 4.1 proposes a number of distal factors; personality (e.g., impulsivity, and extraversion), beliefs, attitudes (e.g., risk perception, distracted driving and maintenance practices), stress related factors (e.g., fatigue) and socio-demographic factors that may predict crash involvement both directly and indirectly. The model further proposes hazard monitoring, violations and errors as proximal factors

(behavioural crash risks) that may have direct links to crash involvement and may mediate the links between the distal factors and crash involvement.

Based on evidence from the developed world, the Big Five personality dimensions were hypothesized to relate to crash involvement indirectly through violations and errors while the link between impulsivity and crash involvement will be mediated by hazard monitoring, violations and errors. Existing findings indicate that fatalism affects risk assessment (Slovic et al., 1981; Teye-Kwadjo, 2019) and may also affect attention to driving. Therefore, fatalistic beliefs were expected to relate to crash involvement through only violations while socio-demographic factors (de Winter & Dodou, 2010; Evans 2000), anxiety and risk perception were hypothesised to relate to crash involvement indirectly through all three mediators; hazard monitoring, violations and errors (Sumer, 2003). The driver stress factors (e.g., fatigue) and distraction were hypothesized to relate to crash involvement via violations, errors and hazard monitoring (Ge et al., 2014; Olson et al., 2009) while the link from safety maintenance practices to crash involvement was predicted to be mediated by errors. Aside from the indirect effects the model also examined direct paths between the distal factors, including the socio-demographic factors, and crash involvement, to investigate whether they were related to crash involvement independently from the measured proximal factors. Two factors (errors and violations) are expected in the DBQ for Ghana based on the Ghanaian factor analysis conducted in Chapter 3. Four factors (aggressive violations, ordinary violations, slips and errors) were expected in the UK DBQ based on the factor structure most commonly reported in Western cultures (e.g., Lajunen et al., 2004).

To examine cultural differences in the mean levels of crash risk between Ghana and the UK, we compared DBQ factors on item level between countries. It is expected that the higher

frequencies of violations and errors reported in Ghana than typically observed in the UK (see Chapter Three) would be replicated here. We also examined whether any observed differences in the crash rates between the two countries could be explained by differences in the levels of the distal factors measured here. Such variations are expected based on the observed differences in traffic culture between Ghana and the UK. Such a development would inform the design of interventions that target salient factors to reduce crash rates in each country.

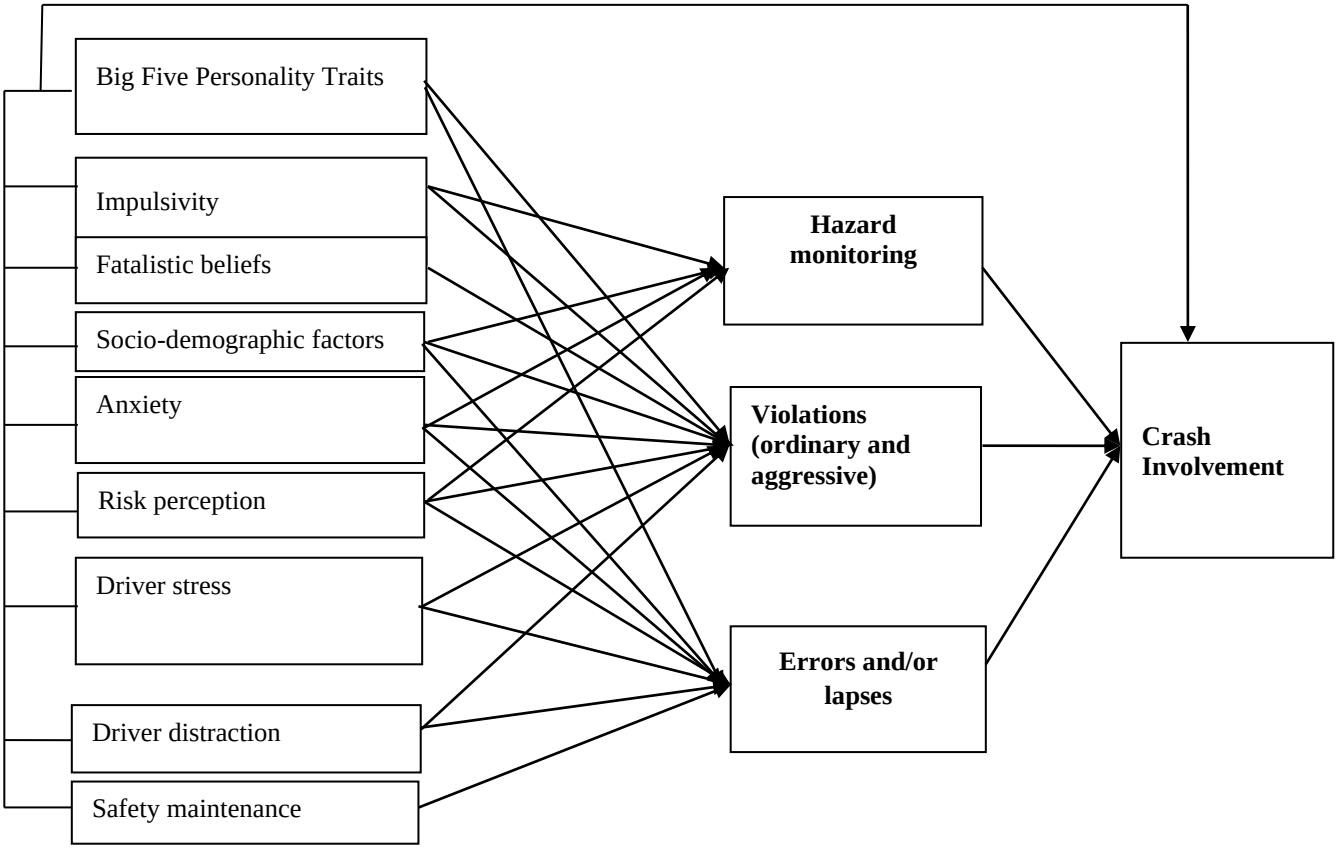

Fig 4.1 Revised hypothesised contextual mediated model of the behavioural predictors of road crashes (adapted from Sumer, 2003)

4.2 Methodology

4.2.1 Sample and data collection

4.2.1.1 Ghana

A total of 478 Ghanaian drivers responded to the survey as described in Table 4.1. The participants' ages ranged from 23 to 86 years (*Mean =39.5, SD =12.51*). The driving experience of participants (4.81% of cases missing) ranged between <1- 46 years of driving (*Mean = 15.81, SD* = 11.04). The participants' daily hours of driving ranged between < 30 mins - 10+hrs *(Mean =3.36, SD = 1.82*) with 0.4% doing up to 10 hours non-stop driving on long journeys *(Mean =2.97, SD = 1.39)*. All participants were selected by convenience and snowball sampling techniques. Data were collected from three regions (Greater Accra, Ashanti, and Volta) in Ghana. Commercial drivers were recruited and provided data at major lorry terminals located in the regional capitals; Accra, Kumasi, and Ho respectively. Private car and truck drivers were recruited through personal approaches in the premises of public and private organisations and mutual acquaintance. Participants identified through mutual acquaintance were called by telephone for interaction concerning study participation. Participants were given £3 in local currency to cover expenses. Participants provided signed informed consent before taking part in the study. The survey procedures received ethical approval from the University of Sheffield Ethics Committee (Reference No: 017665) and The University of Ghana Ethics Committee for the Humanities. Participants were debriefed about all procedures used on submitting their survey.

4.2.1.2 UK

A total of 404 valid responses to an online questionnaire presented via Qualtrics (www.qualtrics.com) were included in the analyses while 30 were excluded due to incomplete responses. Their characteristics are described in Table 4.1. The ages of the participants ranged

from 18 to 75 years (*Mean =34.10, SD =14. 12*). Their driving experience range between 6 months to 58 years (*Mean =14.39, SD =13. 24)*. The participants daily hours of driving ranged between < 30 mins - 10+hrs *(Mean = 2.25, SD = 1.0).* Only 1.0% did up to 8hrs of non-stop driving on long journeys *(Mean =3.78, SD = 0.74)*. The eligibility criterion was holding a full driving licence, however, 8 participants (1.9%) indicated that they did not hold valid driving licences (and therefore were driving illegally) but drove regularly. These participants were retained in the dataset to maintain comparability with the Ghanaian dataset. The survey was distributed to potential participants via the University of Sheffield volunteer list which includes all staff and students of the University who have not opted out. Through the snowball technique, the survey was sent to other individuals outside the university but within the UK. Entry into a prize draw for a £50.00 Amazon voucher was offered as a participation incentive.

Table 4.1 Socio-demographic sample characteristics

Variable	Ghana, *N= 478* %	UK, *N= 404* %	Variable	Ghana, *N= 478* %	UK, *N= 404* %
Sex			Hours non-stop driving		
Female	12.8	64.4	0-30 mins	1.0	2.0
Male	87.2	37.6	30 mins-1hr	11.7	2.0
			1hr-2 hrs	37.4	22.3
Educational level:			2-4hrs	7.2	64.6
No education	0.0	0.0	4-6hrs	24.1	7.9
Basic or < high sch	49.0	0.1	6-8hrs	17.6	1.0
Secondary/high sch.	23.6	6.40	8-10hrs	0.4	-
Diploma/college	13.6	21.3	10+ hrs	0.0	-
1st Degree and above	12.8	72.0	Mode of driving training		-
Mileage			Apprenticeship	49.0	-
<1	0.21	5.7	Formal driving sch.	27.2	-
1-50	19.7	51.0	Friends and family	8.5	-
51-100	33.7	22.8	No training	15.3	-
101-200	14.4	13.9	Licensure		
201-500	22.0	6.7	No licence	0.8	1.9
500+	7.9		Provisional	14.3	2.0
Type of vehicle			Full	84.9	96.1
Private cars	18.2	97.5	License class		-
Taxi cabs	9.0	2.5	A (mopeds; 50-250cc+)	2.1	-
Minibuses /trucks& vans	32.0	-	B(cars < 3000kg)	41.6	-
Lightweight buses	13.4	-	C (33 seater/trucks; 3000- 5500kg)	27.2	-
Big bus/coach	16.3	-	D (vehicles ≤ 8000kg)	14.9	-
Goods trucks	10.0	-	E (tractors/ bulldozers	6.1	-
Assistance		-	F (vehicles > 8000kg)	5.0	-
Not at all	52.1	-	Crash history		
Occasionally	28.9	-	Never	53.1	61.9
Often	14.6	-	Once	37.4	24.3
Very often	2.3	-	Twice	6.7	9.7
Always	1.0	-	Thrice	2.3	2.2
Daily hours driving			Four times	0.4	0.7
0-30 mins	0.6	23.3	Five times or more	-	1.2
30 mins-1hr	11.9	42.3	Crashes in last 3 years		
1hr-2 hrs	36.8	26.2	Never	64.4	78.5
2-4hrs	3.8	6.4	Once	26.2	15.6
4-6hrs	15.7	0.7	Twice	7.3	1.0
6-8hrs	16.3	0.2	Thrice	0.0	-
8-10hrs	11.3	0.5	Four times	0.0	-
10+ hrs	4.6	0.2	Five times or more		0.2
Condition of road usually travelled on		-	Citation in the last 12 months		
Very good	1.7	-	Never	84.3	90.8
Good	34.1	-	Once	11.7	7.7
Neither good nor bad	15.3	-	Twice	1.9	0.2
Bad	21.5	-	Thrice	1.0	
Poor	27.4	-	Four times	0.0	0.7
			Five times or more		0.2

Note: Empty cells in table due to differences in questions asked to Ghanaian and UK sample

4.2.2 Measures

4.2.2.1 Proximal factors

4.2.2.1.1 Driver Behaviour: A 28 item DBQ that combined the well used 27 item version (Lajunen et al., 2004) and the drink and drive item used by Mattson, (2012) was completed in the Ghanaian and UK samples. A detailed description of the DBQ was provided in Chapter Three.

*4.2.2.1.2 Hazard monitoring***:** is a 2-item self-report sub-scale of the Driver Stress Inventory ([DSI] Matthews, Desmond, Joyner, Carcary, & Gilliland, 1997). It is the revised form of the alertness sub-scale of the Driver Behaviour Inventory ([DBI] Glendon et al., 1993) that assesses stress vulnerability among drivers. An example item was, *I make an effort to see what's happening on the road a long way in front of me*. Participants indicated how strongly they agreed with each of the statements that relate to their everyday driving on a scale of 0 (not at all) to 10 (very much). A higher score on the sub-scale represented more attentive hazard monitoring.

4.2.2.2 Distal factors

4.2.2.2.1 Driver stress: The remaining four components of the DSI (Matthews, Desmond, Joyner, Carcary, & Gilliland, 1997) were used to measure driver stress, each with 2 items per scale. The dimensions are; ***Aggression*** (e.g., I really dislike other drivers who cause me problems), ***Dislike of driving*** **(**e.g., I feel tense or nervous when overtaking another vehicle), ***Fatigue*** **(**e.g., I become sleepy when I have to drive for several hours to drive for several hours), ***Thrill-seeking*** **(**e.g., I like to raise my adrenaline levels while driving). The observed alpha coefficients for the subscales including the hazard monitoring ranged from .73 - .87 in

British sample and from .69 - .85 for the US sample. A higher score on the sub-scale represents higher levels of stress feeling.

4.2.2.2.2 Anxiety: The short form of the trait dimension of the State-Trait Anxiety Inventory (STAI-T-6) (Marteau & Bekker, 1992; Fioravanti-Bastos, Cheniaux, & Landeira-Fernandez, 2011) was completed. Examples items were, *I worry too much over something that really doesn't matter* and *I feel secure (reverse coded).* For each of the item, participants indicated '*how they generally feel*' by checking one of the following alternatives: (1) *Almost never,* (2) *Sometimes,* (3) *Often,* (4) *Almost always.* A Cronbach alpha of .73 was observed for the Trait Anxiety factor (Marteau & Bekker, 1992).

4.2.2.2.3 Impulsivity: The Short form of the Barratt Impulsiveness Scale (BIS-15) (Spinella, 2007) measures impulsivity-related behaviours in the general population. It has 3 factors; non-planning (e.g., I plan tasks carefully; *reverse coded*), motor impulsivity (e.g., I do things without thinking) and attention impulsivity (e.g., easily bored solving thought problems). Items are rated on a 4-point Likert scale (1 = rarely/never, 2 = sometimes, 3 = often and 4 = almost always). A higher score indicates greater impulsivity. The scale is treated as unidimensional (α = .83; Meule et al., 2015) in the present study.

4.2.2.2.4 Personality: The 10 item abbreviated version of the Big Five Inventory (BFI) (Rammstedt & John, 2007) was used. The scale has been validated with English and German samples. The BFI consists of 10 short-phrase items, rated on a five-step scale; 1= strongly disagree, 2= disagree a little, 3 neither disagree nor agree, 4 = agree a little and to 5= strongly agree. The items were selected using both consensual expert judgment and empirical item analyses to represent the core (i.e., most prototypical) traits that define each Big Five

personality domain (John, 1989, 1990). Two BFI items address each Big Five dimension with acceptable psychometric properties; Mean retest stability coefficients were .72 – .80 in US, .78- .80 in Germany, and .75 overall, demonstrating that the BFI-10 scales achieved acceptable levels of stability over 6-8 weeks in both cultures. The items cover the dimensions of extraversion (e.g., *I see myself as someone who …* is reserved), agreeableness (e.g. ….is generally trusting), Conscientiousness (e.g. ….tends to be lazy; *reverse coded*), neuroticism (e.g. ….is relaxed, handles stress well) and openness (e.g. ….has few artistic interests).

4.2.2.2.5 Fatalistic beliefs about road crashes: The index for belief in fate measure (Kouabenan, 1998) consists of nine items which describe situations referring to popular beliefs expressing a certain level of fatalism or superstition and to which the subject had to express his/her agreement on a scale of 1-4 (strongly agree, agree, disagree, and strongly disagree). The items cover issues of fate, evil spirits mystery, conspiracy, hearse seeing (seeing a hearse signifies impending doom or disaster), transgressions, black cat (signifies a bad omen), mascots (a person, animal, or object that is thought to bring luck), and consultation of clairvoyants. Items include: 'Accidents are due to fate, nothing can be done about it'; 'certain sections of the road are haunted by genii (evil spirits) who provoke accidents' and 'Road accidents are often unexplainable'. The measure was devised for professional drivers and validated in a Francophone African culture (Cote d'Ivoire). The Cronbach alpha was .78 for the overall scale (Kouabenan, 1998).

4.2.2.2.6 Risk Perception: Risk perception was measured with two items used by Uleberg and Rudmo (2003). First, the respondents rate their subjective evaluation of the probability of them (relative to an average driver) being involved in a traffic accident in the future, ranging from 1: not probable at all to 7: very probable. Second, they express how worried and concerned they

were regarding being hurt in a traffic accident, ranging from 1: not worried at all to 7: very worried. A higher score represents a higher crash risk perception. Iversen and Rudmo (2004) obtained a Cronbach alpha of 0.89 for the measure.

4.2.2.2.7 Distraction: The Susceptibility to Driver Distraction Questionnaire (SDDQ) **(**Feng, Marulanda, & Donmez, 2014) was completed. Self-reported frequency of distraction engagement in the course of driving was assessed by pairing the questionnaire item 'When driving, you ...' with six driver distractions: (1) have phone conversations, (2) manually interact with a phone (e.g., sending text messages), (3) adjust the settings of in-vehicle technology (e.g., radio channel or GPS), (4) read roadside advertisements, (5) visually dwell on roadside accident scenes if there are any, and (6) chat with passengers if there are any. Responses are anchored on a 5-point Likert scale and include 'never', 'rarely', 'sometimes', 'often', and 'very often'. For scoring purposes, these anchors were assigned points from 1 (never) to 5 (very often). A Cronbach alpha of .66 has been reported in a previous study (Feng et al., 2014).

4.2.2.2.8 Safety maintenance: Two items that measure vehicle mechanical maintenance practices related to safety were used (Newman, Watson & Murray, 2002). The questions ask how likely a driver is to do the following before driving; (1) check the water in the radiator and (2) check the pressure in the tyres. Responses are anchored on a 5 point Likert scale; very unlikely (1) to very likely (5). The scale was validated among 204 Australian fleet drivers and was internally consistent with Cronbach's alpha of .81 for a work vehicle, and .79 for a personal car (Newman et al., 2002).

4.2.2.2.9 Socio-demographic factors

Other relevant information collected included; the number of years in driving (experience), average weekly driving mileage, type of vehicle usually used, engagement of assistant drivers for the commercial drivers, daily driving hours and average hours of continuous driving without rest. Others are the mode of training thus whether the driving skills were acquired through formal lessons and instructions from qualified institutions or through other means, validity and class of license held, and citation for traffic offence (number of driving related convictions in the last 12 months). Information on experience with bribery; whether the participants sometimes had to pay/bribe the police or a law enforcement officer for any form of violation in the course of their daily driving, and condition of the road they usually drive on was also collected. The participants were asked to indicate the number of crashes they were involved in as drivers that led to damage to property and injury to persons since they started driving. They were also asked to indicate the number of those crashes that occurred within the last three years. Biographical information including sex, age, and level of formal education was also collected.

4.2.3 Analytic Strategy

Prior to analysis, all items that were negatively scored were reverse coded. An inspection of the data revealed that there were no missing data in the driving questionnaires from the Ghanaian drivers but 5 did have some missing socio-demographic information (e.g., formal education and experience). There were some missing data in the UK sample if participants had not completed all items. As a result, UK analyses were based on 378-404 cases, depending upon the outcome measure analysed. Listwise deletion was used to exclude missing cases in both datasets. Parallel analyses were conducted in the UK and Ghana data sets. The normality of the measures (mean, standard deviation, skewness, and kurtosis) and reliability (Cronbach alpha) were

computed. Pearson correlations among the study variables were calculated to check collinearity diagnostics. To determine the level of consistency in the observed factor structure of the DBQ in Ghana, a second EFA was conducted based on the main data set (n = 478). The primary analyses involved mediation analyses of the relationship between distal factors and crash involvement via proximal factors. To achieve this a two-step process to model estimation (Anderson & Gerbing, 1988) was adopted in which a measurement model was first constructed to examine the factor structure and correlations between the latent constructs via Confirmatory Factor Analysis (CFA). The measurement model related each construct to their latent indicators. Next, the identified measurement model was extended to model the hypothesised mediating relationships in a Structural Equation Model (SEM) by adding the crash involvement outcome variable and including the hypothesised pathways between distal and proximal factors.

CFA was first used to confirm the factor structure of the DBQ in the Ghana and UK samples. In the Ghanaian sample, the initial model specified the 2-factor identified as most appropriate for a Ghanaian sample in Chapter Three and the 2-factor model was expected in the present data. The CFA on the UK data specified the 4-factor DBQ structure typically reported in the Western literature (e.g., Lajunen et al., 2004) and was expected to be the best model. There was less certainty over how the drink-drive item would work in the UK based on its performance in previous cross-cultural studies (Lajunen et al., 2004).

The parameters of the model in the study were estimated using the Robust Maximum Likelihood Estimation method (MLR; Muthen & Muthen, 2012). MLR utilises the Satorra-Bentler $\chi 2$ statistic (1988) which corrects the scaling of the $\chi 2$ statistic (and thus of CFI, TLI and RMSEA) when assumptions of multivariate normal distribution (i.e. skewness and kurtosis) are not met, and computes standard errors (for model parameter estimates) that are

similarly robust to deviations from multivariate normality (Byrne, 2013). The adequacy of model fit was assessed using the benchmark fit indices as specified in the previous chapter (see Section 2.3 of Chapter Three). Only the fully standardised estimates were reported in the study. All models were estimated in Mplus v.7.11 (Muthen & Muthen, 2012).

This study employed an item 'parcelling' method in which items were summed together to form parcelled indicators of the latent constructs (Coffman, & MacCallum, 2005; Kishton & Widaman, 1994). Parcelling is the aggregation (sum of averages) of several individual items onto fewer indicators of latent constructs (Bagozzi & Edwards, 1998; Coffman, & MacCallum, 2005). Parcelling was necessary for the present study due to the large parameter (due to many factor indicators) to sample ratio that would otherwise affect model estimation. Parcelling reduces the model parameters and therefore allows models to be fitted with the available sample size. In the present study, a 'two-faced approach' was adopted in which items were parcelled based on their item loadings within a primary CFA (Kim & Hagtvet, 2003). Specifically, item parcels were computed using a 'construct-to-balance' method (Little et al., 2002), where the highest loading item on a construct is parcelled with the lowest loading item on that construct and so forth, a process that continues iteratively until each construct has a maximum of 4 parcelled indicators. For example, impulsivity was measured with 15 items which were combined into 3 parcelled indicators by averaging items 1, 2, 3, 6 and 7 as the first parcelled indicator, items 4, 5. 8, 9 and 11 as the second parcelled indicator and items 10, 12, 13, 14 and 15 as the third parcelled indicator.

Other parcelled factors included anxiety (6 items combined into 2 indicator parcels), distraction (6 items; combined into 2 parcelled indicators), and belief (9 items; combined into 3 parcelled indicators). Parcelling of the DBQ factors in Ghana include; violations (16 items, combined

into 4 parcelled indicators) and errors (8 items, combined into 2 parcelled indicators). For the UK data, the DBQ items were parcelled as; ordinary violations (8 items, combined into 2 parcelled indicators), errors (8 items, combined into 2 parcelled indicators) and lapses (8 items, combined into 2 parcelled indicators). The 3 items of the aggressive violations were not parcelled.

It should be noted that the use of parcels is not without criticism, given the empiricist philosophical perspective that data should be modelled in a way that is as representative of the original observations as possible and should be free for subjective contamination by the researcher (Little, Cunningham, Shahar, & Widaman, 2002). However, as summarised by Little, Rhemtulla, Gibson, and Schoemann (2013), parcelling has numerous benefits (relative to analysing individual items) from a psychometric perspective, including increases in reliability communalities and the ratio of common-to-unique factor variance with respect to the latent constructs on which the parcels are loaded. Further, models with parcelled indicators (as opposed to items) are more parsimonious in that fewer parameters are estimated. Parcelling was necessitated here by the size of the model relative to the number of observations. Parcels offer a flexible and theoretically justifiable alternative to modelling items when the sample size is limited and offer advantages over the statistically inferior approach of modelling scale scores that are based on total aggregation of items (Coffman & MacCallum, 2005).

Models of direct and indirect effect were examined in which distal factors were modelled as predictors of crash involvement via errors, violations and hazard monitoring (our proximal risk factors for crash involvement [see Figure 4.1 above]). To test the meditational paths, 95% confidence intervals were computed from 10000 bootstrap samples (MacKinnon, Lockwood, & Williams, 2004). Bias-corrected bootstrapping was used to create confidence intervals to

determine the significance of the indirect effects. Bootstrapping involves resampling the data with replacement a given number of times to generate a nonparametric estimation of the entire sampling distribution of the indirect effect (Cheung & Lau, 2008; Preacher & Hayes, 2004). Such samples then form an approximate normal distribution as the sample size is effectively increased to the *n* of bootstrapped samples. This method of testing significance is recommended over other tests, such as the Sobel test, as it has a higher power while controlling the Type I error rate (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). Whilst it may be argued that the 95% Bias-Corrected Bootstrapped Confidence Intervals (BCa CI's) used in this study will differ across replications, such differences are generally arbitrary once one reaches ≥ 5,000 samples (Hayes, 2013). The use of 10 000 bootstrapped samples in the present study was therefore justified.

Indirect effects from each distal predictor variable to crash involvement via each hypothesised mediator variable were calculated. For each mediator, the product of the distal factor-to-mediator and mediator-to-outcome path coefficients (*ab*) represents the relative indirect effect of that distal factor on the outcome variable; crash involvement via that mediator. In each analysis, mediator variables were allowed to correlate. Mediation (i.e. indirect) effects are significant at $p<.05$ when 95% confidence intervals (CI) exclude zero. Next, a series of structural models; (M1) all predictors modelled as latent factors with each of the mediators entered separately, the hypothesised model (M2; all mediators entered at the same time) that included the direct and indirect paths (partial mediation; see Fig 4.1 for the hypothesised model) and (M3) the full mediation (direct paths removed) were tested. The structural paths were added to the CFA in the modelling. To test the predictive effect of the most salient demographic variables on hazard monitoring, violations, errors and crash involvement, demographic factors; sex, age, mileage and experience (years in driving) were added to the

models. Sex was dummy coded and treated as a categorical variable while age, mileage and experience were treated as continuous variables. Sex, age, mileage and experience may have direct and indirect effects on crashes or may be fully or partially mediated by hazard, violations, errors and lapses. Inclusion of these variables in the models also ensures that spurious relationships between factors are not identified as a result that both are related to age, sex, mileage and experience.

The minimum acceptable sample size required to obtain adequate statistical power for the models being tested in the present study following the parcelling ranges between 215 and 430 based on the 5 or 10 observations per estimated parameter rule of thumb (Bentler & Chou, 1987; Chou & Bentler, 1995). The samples for the present study were therefore satisfactory. Modification indices were considered in fitting the models. Modification indices estimate the amount by which the overall model χ^2 statistic would decrease if a particular path currently fixed to zero path was freely estimated. It therefore estimates the χ^2 for adding paths; thus the greater the value of the modification index the better the predicted improvement in the overall model fit if that path were added (Kline, 2005).

Differences in mean levels of the distal factors between Ghana and the UK were tested using between participant t-test (immediate form of the t-test) in Stata (Stata Corp, 2013). The effect sizes were interpreted using Cohen's *d* (0 -.20 = small effect, .21 - .50 = medium effect, > .50 = large effect). One-way analysis of covariance (ANCOVA) in SPSS (IBM Corp, 2011) was used to test differences in DBQ items (tendency to commit aberrant driving behaviours) between Ghana and UK after controlling for demographic factors; age, sex, weekly mileage, and experience and all distal predictors in the study. The effect sizes are indicated by the corresponding eta squared values and were interpreted using Cohen's (1998) guidelines; .10,

.25, and .40 for small medium and large effect sizes respectively. National differences in crash rates between Ghana and the UK was tested with Logistic Regression. A framework to summarise the data analyses strategy is presented in Figure. 4.2 below.

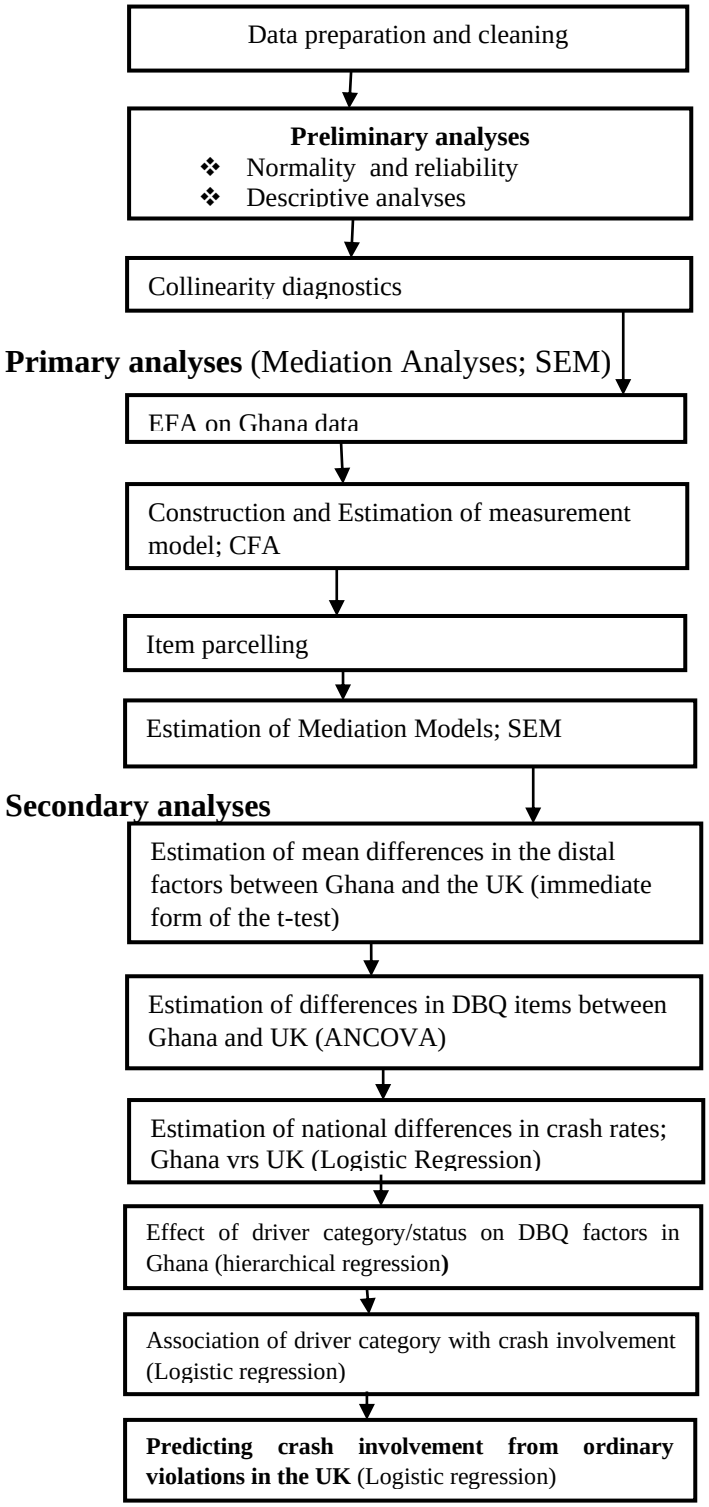

Fig 4.2 Analytic framework

4.3 Results

4.3.1 EFA of the DBQ in Ghana

An EFA of the DBQ was conducted using the Ghanaian main study dataset to determine the robustness of the measure across samples. Similar to study 2 (Chapter Three) principal axis factoring with oblique rotation was employed given that DBQ factors are usually correlated (de Winter et al., 2010). Similar to the study 2 (Chapter Three) procedure, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The factorability of the correlation matrix was supported by a Kaiser-Meyer-Oklin measure of sampling adequacy of .82, meeting the commonly recommended value of .6 and above (Kaiser, 1970, 1974) and the significance of Barlett's Test of Sphericity (Bartlett, 1954) (χ^2 (383) = 5.91, $p < .001$). The initial EFA identified seven components with eigenvalue exceeding 1, explaining a total of 79.66% of the variance. The scree plot (Appendix B2) revealed a clear break (elbow) after the second component. Therefore, two components were retained for further analysis.

Following oblique rotation the two-factor solution explained 77% of the variance, with component one contributing 48.2% and component two contributing 28.8%. The pattern of loadings (see Appendix B3 for the EFA loadings of the DBQ items based on the main study sample in Ghana) was strikingly similar to that observed Chapter Three. The first factor combined the majority of the aggressive and ordinary violations items while the second factor combined the majority of the errors and one lapse items. The items that loaded onto each factors were exactly the same as observed in Chapter Three (see Chapter Three, Table 3.1). Two items; E8 and L7 that originally did not load onto any factor in the previous study (Chapter Three) cross loaded onto both factors in the present dataset. However, the differences in loadings were less than .2 (E8; .51 for violations and .52 for errors, L7; .50 for violations and

.51 for errors) and could not be included (Bryant, & Yarnold, 1995). The 2 factor structure observed in Study Two (Chapter Three) was therefore replicated here.

4.3.2 CFA of the DBQ (Ghana and UK)

In the Ghana data, the CFA indicate that the two factor model of the DBQ (violations and errors) based on 24 items has a better fit for the data (χ^2= 831.98 (118) p<.001, RMSEA = .09, CFI = .96; TLI = .96) than a 1-factor model (χ^2= 853.57 (151) p<.001, RMSEA = .10, CFI = .93; TLI = .92). A 3-factor model (violations, errors and lapses) has a poorer fit (χ^2= 1110.42 (169), p<.001; RMSEA = .11, CFI = .87; TLI = .86) than the 1-factor model while the 4-factor model (ordinary violations, aggressive violations, errors and lapses) had the worst fit (χ^2= 1933.75 (177), p<.001; RMSEA = .17, CFI = .89; TLI = .89). The results show that the 2-factor structure of the DBQ in Ghana derived from Chapter Three was supported in this independent data set. An excellent fit was obtained for the present 2-factor structure as indexed by the CFI and TLI and the .09 RMSEA fit was acceptable (Hu & Bentler, 1999).

Two competing models; 3-factor and 4-factor were specified for the UK data based on existing findings (e.g., Lajunen et al., 2004; Reason et al., 1990). The 3-factor model (violations, errors and lapses) gave a good fit (χ^2= 1068.44 (321) p<.001, RMSEA = .08, CFI = .97; TLI = .97) but the the 4-factor model (ordinary violations, aggressive violations, errors and lapses) fit better (χ^2= 979.08 (318), p<.001; RMSEA = .07, CFI = .97; TLI = .96). In comparison, a 2-factor model (violations and errors) had a poor fit (χ^2= 1149.89 (290), p<.001, RMSEA = .10, CFI = .63; TLI = .60).

4.3.3 Measurement model CFA (Ghana and UK)

For the Ghanaian data, the measurement model consists of 19 latent constructs (16 distal and 3 proximal constructs) while the UK had 21 latent constructs (16 distal and 5 proximal), as there were 4 DBQ factors in the UK and 2 in Ghana. The Ghanaian measurement model (see Table 4.2, M1a) showed adequate fit with all items having significant (all $p<.001$) and good loadings (.58 – .92) on their respective latent variables. No theoretically sound modification indices were suggested that could have improved model fit via MPlus' modification indices routine. Similarly, the full measurement model for the UK data (see Table 4.3, M1b) showed satisfactory fit to the data with all items having significant (all $p<.001$) and good loadings (.50 – .89) on their respective latent variables.

Table 4.2 Fit indices for the measurement and structural models fitted to the Ghanaian data

Model	χ^2	df	CFI	TLI	RMSEA (90% CI)	TRd	∆df
CFA Model							
M1a: measurement model	725.20	153	.94	.92	.09 (0.08 – 0.11)		
SEM Model							
M2: Partial mediation	390.41	70	.90	.87	.08 (0.07–0.12)	23.81**	1
M3: Full mediation	414.22	71	.91	.89	.12 (0.11 – 0.13)		

*Notes: χ^2 = chi-square; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; CI = Confidence Interval; TRd = Sattora-Bentler Scaled Chi-Square Difference; ** = p<0.001*

Table 4.3 Fit indices for the tested models; measurement and structural for UK data

Model	χ^2	df	CFI	TLI	RMSEA (90% CI)	TRd	∆df
CFA Model							
M1b: measurement model	682.67	102	.96	.95	.09 (.07 – .11)		
SEM Model							
M2: Partial mediation	401.410	95	.90	.87	.09 (.07–.10)	21.69**	1
M3: Full mediation	612.39	101	.89	.86	.10 (.10 – .15)		

*Notes: χ^2 = chi-square; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; CI = Confidence Interval; TRd = Sattora-Bentler Scaled Chi-Square Difference; ** = p< .001*

4.3.4 Descriptive statistics normality and reliability analyses

As shown in Table 4.4 all the measures met the assumptions of univariate normality; skewness and kurtosis were within acceptable range of below 2 and 7 respectively (Curran, West & Finch, 1996) except lapses in the UK. Even using a more stringent cut-off criterion of between ±2 (Tabachnick & Fidell, 2013), most of the variables were either normally distributed or did not substantially depart from normality. All the measures showed acceptable reliability coefficients (> .7, Cronbach, 1995) except for the agreeableness personality dimension (.65) and the fatigue scale (.68) of the Driver Stress Inventory in Ghana (Table 4.5). The correlations among all the study variables (see Appendix D) for correlation matrices tables for both datasets) for the Ghanaian data were acceptable in terms of multicollinearity, falling below .70 (Dormann et al., 2013; Tabachnick & Fidell, 1996, p.164). For the UK data conscientiousness correlated strongly with openness (r = .90), indicating multicollinearity. Conscientiousness was dropped in the primary analysis of the UK data. Furthermore, the Variance Inflation Factor (VIF) that checks for multicollinearity among the predictors were within acceptable levels. All VIF values (2.78 – 4.880) were < 5 and tolerance values (.46 – .48) exceeded the recommend threshold of 0.20 (Hair, Ringle, & Sarstedt, 2013; Hair et al., 2010). As shown in Table 4.4 the mean levels

of distal factors; anxiety, fatalistic beliefs, and distraction were significantly higher (with medium to large effect sizes) in Ghana compared to the UK. Conversely, hazard monitoring and fatigue were rated lower in Ghana than the UK while thrill seeking, impulsivity, neuroticism, aggression and dislike for driving were rated higher in the UK compared to Ghana.

Table 4.4 Means, SD, Skewness, Kurtosis and Cronbach Alpha of scales

	GH		UK		Effect size	GH		UK		GH	UK
Variable	**Mean**	**SD**	**Mean**	**SD**	**Cohen's *d***	**Skewness**	**Kurtosis**	**Skewness**	**Kurtosis**	**α**	**α**
Anxiety	19.97	3.51	14.81	2.17	1.77*	-1.27	1.22	.91	3.14	.76	.85
Impulsivity	34.03	4.09	34.66	6.23	-.12*	.40	.08	2.31	2.00	.78	.80
Extraversion	6.90	2.76	6.37	2.96	.19*	-.66	-.94	-.30	-.82	.85	.69
Agreeableness	6.87	1.82	4.92	2.46	.90*	-.15	-.17	-.14	-1.27	.65	.81
Conscientiousness	5.72	1.26	5.75	3.00	.01	-.26	3.27	-.32	-1.20	.77	.75
Neuroticism	5.64	3.30	6.35	2.55	-.24*	.19	-1.71	-.37	-.98	.90	.64
Openness	6.16	2.18	5.60	3.00	.22*	-.02	-.93	-.21	-1.28	.87	.72
Fatalistic Beliefs	23.44	10.95	11.46	3.39	1.48*	.08	-1.63	2.03	4.66	.98	.86
Risk perception	8.08	4.79	7.88	3.60	.05	-.07	-1.69	.33	-.92	.96	.74
Aggression	11.47	5.93	14.36	5.01	-.53*	-.10	-1.18	-.73	-.37	.70	.80
Dislike for driving	9.37	6.30	12.73	5.92	-.55*	.37	-1.23	-.37	-1.27	.70	.82
Hazard monitoring	7.34	5.53	13.81	6.89	-1.04*	.81	-.47	-.91	-.81	.79	.97
Fatigue	9.66	6.57	13.19	5.34	-.59*	1.25	1.83	-.50	-.93	.68	.89
Thrill seeking	9.47	6.08	10.09	6.45	-.10*	.41	-1.21	.38	-1.36	.88	.90
Distraction	18.25	6.62	15.53	3.14	.53*	.51	-.44	.10	.34	.86	.61
Maintenance	8.40	2.52	4.46	2.22	1.66*	-1.44	.78	.58	-.56	.91	.80
Violations	46.50	27.22				.93	-.87			.98	
Ord viol			13.61	6.60				1.76	4.15		.92
Aggressive viol			4.97	2.78				2.17	5.14		.85
Errors	17.95	7.22	11.08	6.18		.93	.45	3.75	5.91	.72	.96
Lapses			14.16	6.56				2.24	8.86		.91

GH = Ghana (N = 478), UK (N = 404)
**Effect sizes significantly different from 0*
Empty cells in table due to differences in factor structure of the DBQ between Ghana and UK

4.3.5 Testing the structural model

The measurement models indicated that the latent variables required for testing the proposed mediating pathways from distal factors to crash involvement were effectively estimated from the observed variables in both the Ghana and UK datasets. Self-reported number of crashes

within the last 12 months was used as a single indicator of the outcome variable and demographic variables; age, sex, mileage and experience were added to the model as distal factors to predict proximal factors and crash involvement. The structural model tests a general model that prescribes the relationships among the latent (distal and proximal) variables (see Figure 4.3). The goodness of fit indices of several nested models were compared prior to selecting the final models in the two data sets. As shown in Tables 4.2 and 4.3, the partial mediation model (Direct and indirect paths) with all mediator variables included (M2) provided a better fit to the data than the full mediation model (M3). M3 had direct paths between distal factors and crash involvement eliminated and proposed that the relationship between distal factors and crash involvement is fully mediated by the proximal factors (hazard monitoring, violations and errors). Indeed, a chi-square difference test revealed that when a model that excluded the direct path between distal factors and crash involvement was tested i.e. M3, the overall model fit worsened in both data sets; Ghana (χ^2 (1) = 23.81, p<.001), UK (χ2 (1) = 21.69, p<.001), in comparison to M2.

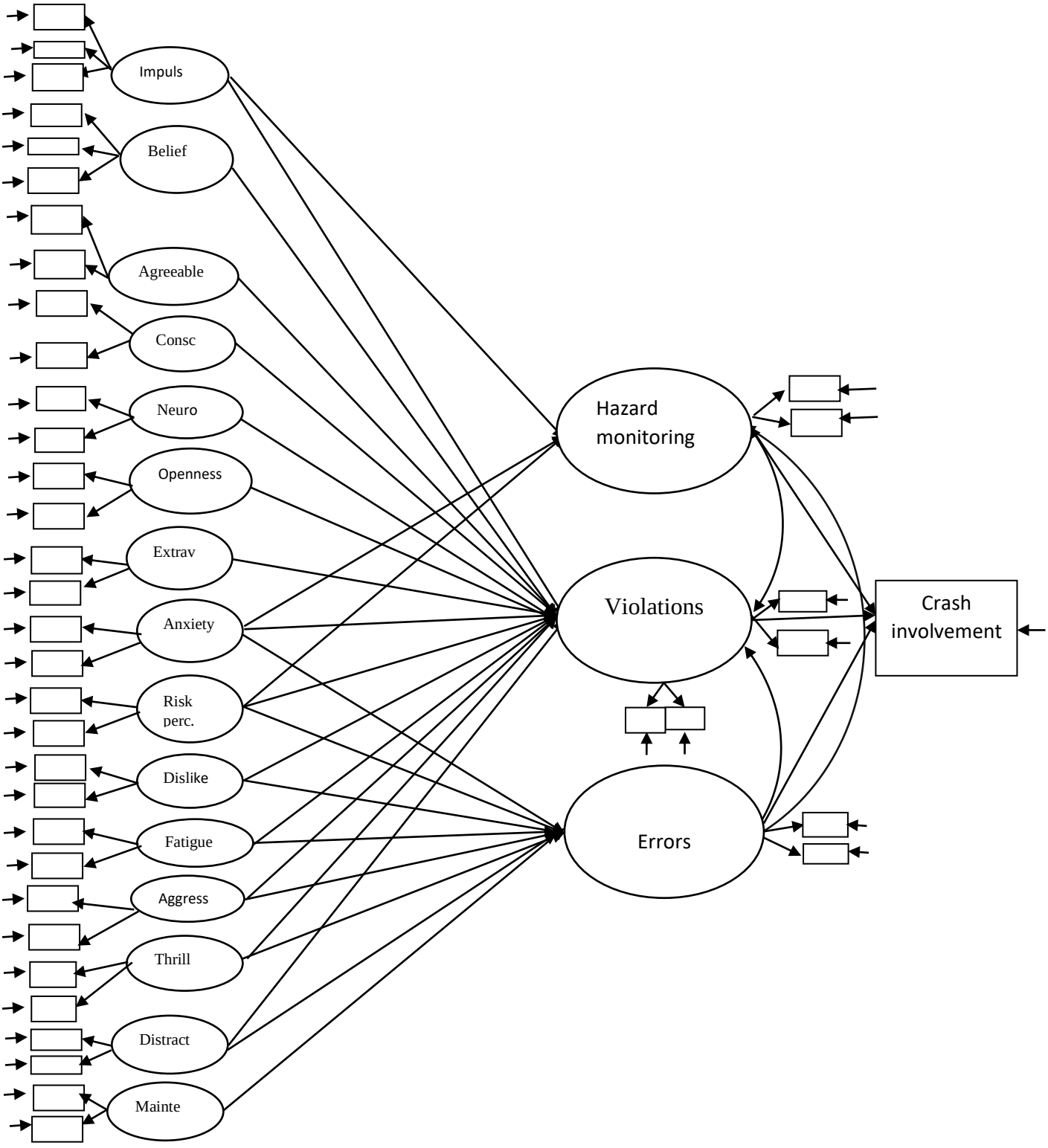

Fig. 4.3 Structural mediation model for the prediction of crash involvement from distal factors via proximal factors in Ghana. Note: This model differs for the UK with violations having 2 sub-categories; ordinary and aggressive and lapses separated from errors

4.3.5.1 Mediation results (Ghana)

Models (direct and indirect) of the effects of the relationships between distal factors and crash involvement via proximal factors; hazard monitoring, violations, errors and lapses for Ghana and UK are shown in Tables 4.5a-c. Hypothesised pathways from the distal context to the proximal context for Ghana are presented in Figure 4.3 while the path diagram is presented in Figure 4.4. All the three proximal pathways to crashes in Ghana; from hazard monitoring (B = -.21 p<.05), violations (B = .29, p<.05) and errors (B = .17, p< .05) were significant. The direction of the effects was that lower levels of hazard monitoring and higher frequencies of violations and errors are associated with higher crash involvement.

4.3.5.1.1 Anxiety

As shown in Table 4.5a, the path from anxiety to crash involvement was fully mediated by the combined effect of violations and errors such that higher levels of anxiety increase the frequency of violations and errors that results in higher crash involvement. The paths from anxiety to violations and errors were significant. The indirect paths to crash involvement from anxiety via the mediators; violations and errors were significant as indicated by the 95% BCa CI's which did not include zero. The direct path to crashes from anxiety (B = .01, p = .94) was non-significant.

4.3.5.1.2 Personality

4.3.5.1.2.1 Impulsivity; was related to poor hazard monitoring and thus predicted crash involvement indirectly via this route. Table 4.5a shows that this indirect pathway was significant. In addition, Figure 4.4 shows that the direct path between impulsivity and

crashes (B = .36, p<.001) was significant. Therefore hazard monitoring only partially mediated the association between impulsivity and crash involvement and the remaining association was not explained by errors or violations.

4.3.5.1.2.2 Aggression and thrill seeking

There was a significant indirect path between aggression and crashes involvement via violations (Table 4.5b). Higher aggression was associated with increased violations. As shown by Figure 4.4 the direct path to crash involvement from aggression (B = .09, p<.05) was significant. The association between thrill-seeking and crashes involvement was fully mediated by and errors such that higher levels of thrill seeking increases the frequency of errors that increases crash involvement. The direct path to crash involvement from thrill seeking (B = .04, p = .24) was non-significant.

4.3.5.1.2.3 The Big Five Personality: Agreeableness and conscientiousness; have direct effects on crashes without passing through a mediator such that lower agreeableness and lower conscientious are associated with higher the crash involvement, as shown in Figure 4.4. As shown in Table 4.5a agreeableness predicted violations and errors and conscientiousness predicted errors. However, the indirect paths to crashes from agreeableness and conscientiousness via violations and errors were non-significant; the 95% BCa CI's included zero.

4.3.5.1.3 Safety attitudes; risk perception and fatalistic beliefs

4.3.5.1.3.1 Risk perception: The association between risk perception and crash involvement was fully mediated by significant indirect pathways via hazard monitoring

and violations (Table 4.5b). Lower levels of risk perception were associated with lower levels of hazard monitoring and higher levels of violations that in turn were modelled to increase crash propensity. As shown by Figure 4.4 the path from risk perception to crashes (B = -.06, p = .06) was non-significant.

4.3.5.1.3.2 Fatalistic beliefs

Violations and errors jointly mediated the path from fatalistic belief to crash involvement such that stronger fatalistic beliefs, increase violations and errors frequency that increases crash propensity, with significant indirect pathways shown in Table 4.5b. The direct path to crash involvement from fatalistic beliefs (B = .01, p = .69) was not significant.

4.3.5.1.4 Distracted driving

The effect of distraction on crash involvement was partially mediated by indirect pathways through hazard monitoring and errors (Tables 4.5b). Higher levels of distraction were associated with poorer hazard monitoring and increasing the frequency of errors. As shown by Figure 4.4, the direct path from distraction to crash involvement (B = .13, p<.01) was also significant, showing mediation was only partial.

4.3.5.1.5 Maintenance behaviour

There were significant indirect pathways (Tables 4.5c) from maintenance practices to crash involvement via violations and errors. Frequent maintenance practices increase the frequency of violations and errors that increases crash propensity. The direct path to crash involvement from maintenance practices (B = .01, p = .81) was not significant.

4.3.5.1.6 Fatigue

The association between fatigue and crashes involvement was fully mediated by indirect paths via violations and errors (Table 4.5b). Higher levels of fatigue were associated with higher frequency of violations and errors. The path to crash involvement from fatigue (*B* = .03, *p* = .59) was non-significant.

4.3.5.1.7 Demographic predictors: As shown in Figure 4.4 the direct path to crashes from age (B = -.17, *p*<.05), and sex (B = .22, *p*<.01) were significant such that being younger and male is associated with higher crashes. The non-significant direct paths from the demographic variables to crashes include; mileage (B = .07, *p* = .20), and experience (B = -.14, *p* = .07). **Age:** as shown in Table 4.5c, there was a significant indirect path between age and crash involvement via violations such that decreasing age leads to higher levels of violation that in turn increases crash propensity. **Sex:** The indirect path between sex and crashes via violations and errors were non-significant. Sex therefore related directly to crashes without mediation effect from violations and errors. **Mileage:** There were significant indirect pathways from mileage to crash involvement via hazard monitoring, violation and errors. Increased mileage was associated with lower levels of hazard monitoring and more frequent violations and errors that increase crash propensity. **Experience:** did not relate directly with crash involvement neither did it work through any of the mediators.

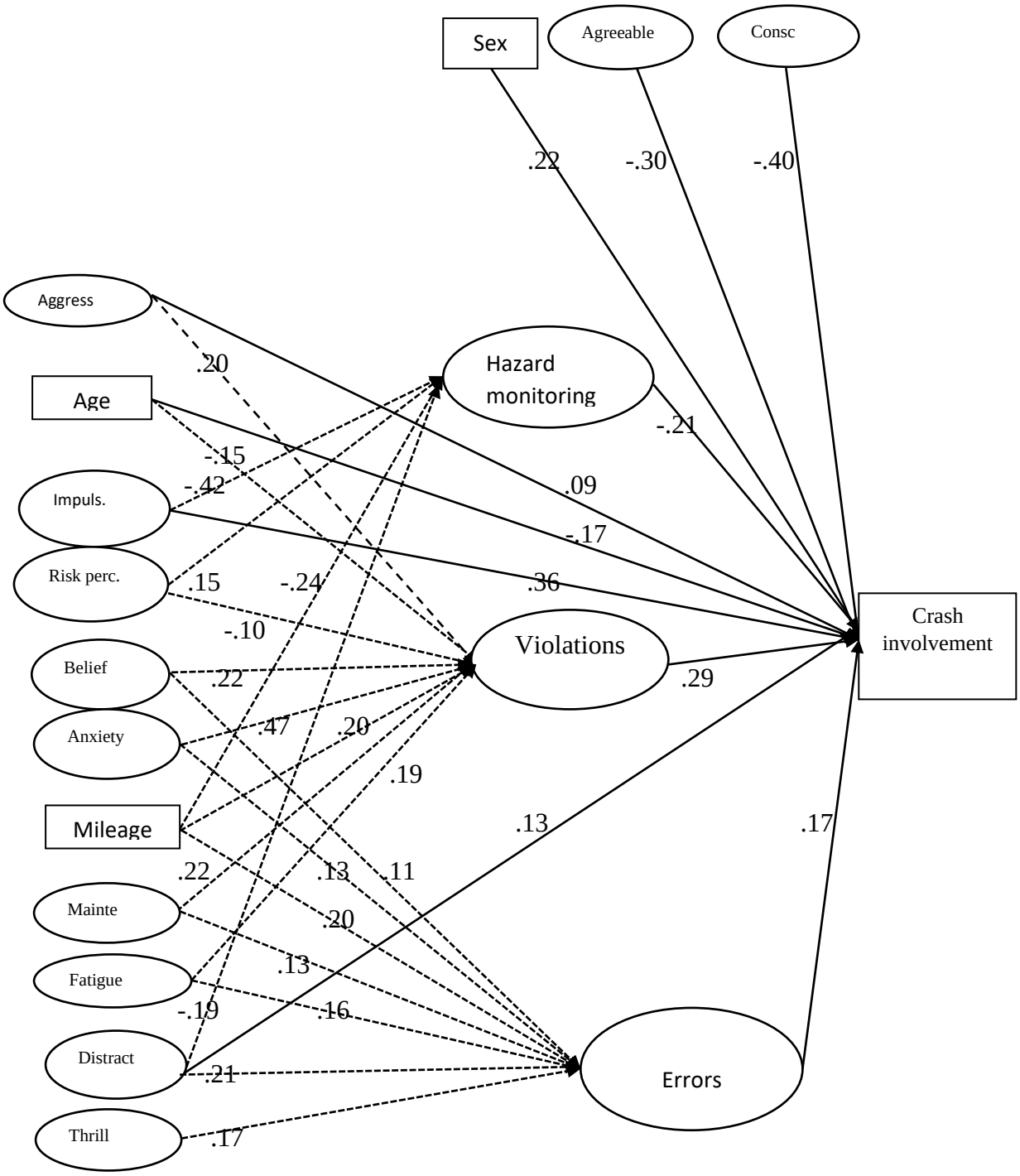

Fig.4.4 Path diagram: mediation model for the prediction of crash involvement from distal factors via proximal factors in Ghana. Note: Indirect paths are shown in dotted lines and only significant paths are shown.

4.3.5.2 Mediation results (UK)

The model for the UK has the same structure as the model applied to the Ghanaian data except that violations had two components; ordinary and aggressive and there were separate errors and lapses factors. The path diagram for UK is presented in Figure 4.5. Four of the 5 proximal pathways to crash involvement specified for the UK; hazard monitoring (B = -.09 p<.05), aggressive violations (B = .15, p<.05), errors (B = .13, p<.05) and lapses (B = .22, p<.001) were independently significant. Ordinary violations were not independently significant (B = .03, p = .06), however. The direction of the effects indicates that lower levels of hazard monitoring and higher frequencies of aggressive violations, errors and lapses result in higher crash involvement.

4.3.5.2.1 Anxiety and driver crash risks

Similar to the Ghana analysis, the link to crash involvement from anxiety was partially mediated by errors with higher levels of anxiety linked to more frequent errors that result in higher crash involvement. Unlike the Ghana analyses, however, there was no indirect path from anxiety to crashes via violations; anxiety was associated with aggressive violations but the overall indirect pathway was non-significant. As shown in Figure 4.5 the direct path to crashes from anxiety (B = .20, p<.01) was significant.

4.3.5.2.2 Personality factors and driver crash risks

4.3.5.2.2.1 Neuroticism: the path from neuroticism to crash involvement was fully mediated by hazard monitoring. The direction of the effects was such that higher levels of neuroticism reduce hazard monitoring resulting in higher crash involvement. The path to crashes from neuroticism (B = .01, p = .41) was non-significant. As shown in Table 4.5a

the path from neuroticism to hazard monitoring was significant. The indirect path to crashes from neuroticism via the mediator; hazard monitoring was significant.

4.3.5.2.2.2 Impulsivity: the path to crash involvement from impulsivity was partially mediated by errors. The direction of the effects was such that higher levels of impulsivity lead to higher levels of errors that results in higher crash involvement. The paths to crashes from impulsivity (B = .42, p<.001) was significant. As shown in Table 4.4a the path from impulsivity to errors and the indirect path from impulsivity to crash involvement via errors were significant.

4.3.5.2.2.3 The Big Five Personality: Extraversion and agreeableness, therefore related directly to crash involvement with any of the mediators. The directions of the effects indicate that higher levels of extraversion and less agreeableness increases the propensity of crash involvement. As shown by Figure 4.5 the path from extraversion (B = .19, p<.001), agreeableness (B = -.15, p<.01), to crashes were significant. As shown in Table 4.5a the paths from extraversion to three mediators; hazard monitoring, ordinary violations and errors were significant. The paths from agreeableness to ordinary violations and errors were significant. However the indirect paths to crashes from extraversion and agreeableness were non-significant (p>.05). The 95% BCa CI's included zero.

The path from thrill seeking to crash involvement was fully mediated by hazard monitoring. The direction of the effects was such that higher levels of thrill seeking reduce hazard monitoring resulting in higher crash involvement. The paths to crashes from thrill seeking thrill (B = .08, p = .11) was not significant. As shown in Table 4.5b the path from

thrill to hazard monitoring was significant. The indirect paths to crashes from thrill seeking via the mediator; hazard monitoring was significant.

4.3.5.2.3 Distracted driving and crash involvement

The effect of distraction on crash involvement was partially mediated by the combined effect of hazard monitoring and errors such that higher levels of distraction impairs hazard monitoring and increases the frequency of errors resulting in higher crash involvement. As shown by Figure 4.5, the path from distraction to crash involvement (B = .17, p<.01) was significant. As shown in Tables 4.5b the paths from distraction to hazard monitoring and errors were both significant and the indirect paths to crashes from distraction via the mediators hazard monitoring and errors were significant.

4.3.5.2.4 Effect of driver stress indices on crash risks

Dislike for driving and fatigue related directly to crash involvement without a mediation. The directions of the effects indicate that higher level of dislike for driving and driving when fatigued results in the higher the crash involvement. As shown in Figure 4.5 the paths from dislike for driving (B = .10, p<.05) and fatigue (B = .22, p<.01) to crash involvement were significant. As shown in Table 4.5b dislike for driving predicted hazards monitoring and errors while fatigue predicted errors and the violations; ordinary and aggressive. However the indirect paths to crashes from dislike for driving and fatigue via the mediators were non-significant (p>.05). The 95% BCa CI's included zero.

4.3.5.2.5 Demographic predictors

Age: The path from age to crashes (B = -.04, p = .478) was not significant. From Table 4.4c the path from age to errors was significant. The indirect path from age to crashes via the mediator errors was significant. Errors fully mediated the relationship between age and crash involvement such that the older, the more frequent the errors that are associated with higher crashes. ***Sex:*** As shown in Figure 4.5 the path from sex to crashes (B = .17, p<.05) was significant such that maleness is associated with higher crash involvement. As shown in Table 4.5c the paths from sex to ordinary violations, aggressive violations and errors were significant. The indirect paths between sex and crashes via the mediator's aggressive violations and errors were significant. Therefore, sex related both directly and indirectly to crashes through the combined effect of aggressive violations and errors. The direction of the effects indicates that maleness increases aggressive violations leading to higher crash propensity while femaleness increases the frequency of errors that increases crash propensity. ***Experience:*** The path from experience to crashes (B = .01, p = .10) was not significant but as shown in Table 4.4c the path from experience to lapses was significant and the indirect path between experience and crashes via the mediator lapses was significant. Lapses fully mediated the relationship between experience and crash involvement such that lower levels of driving experience are associated with frequent lapses that increase crash propensity. Mileage predicted crash involvement directly (B = .08, p<.05) without going through any of the mediators.

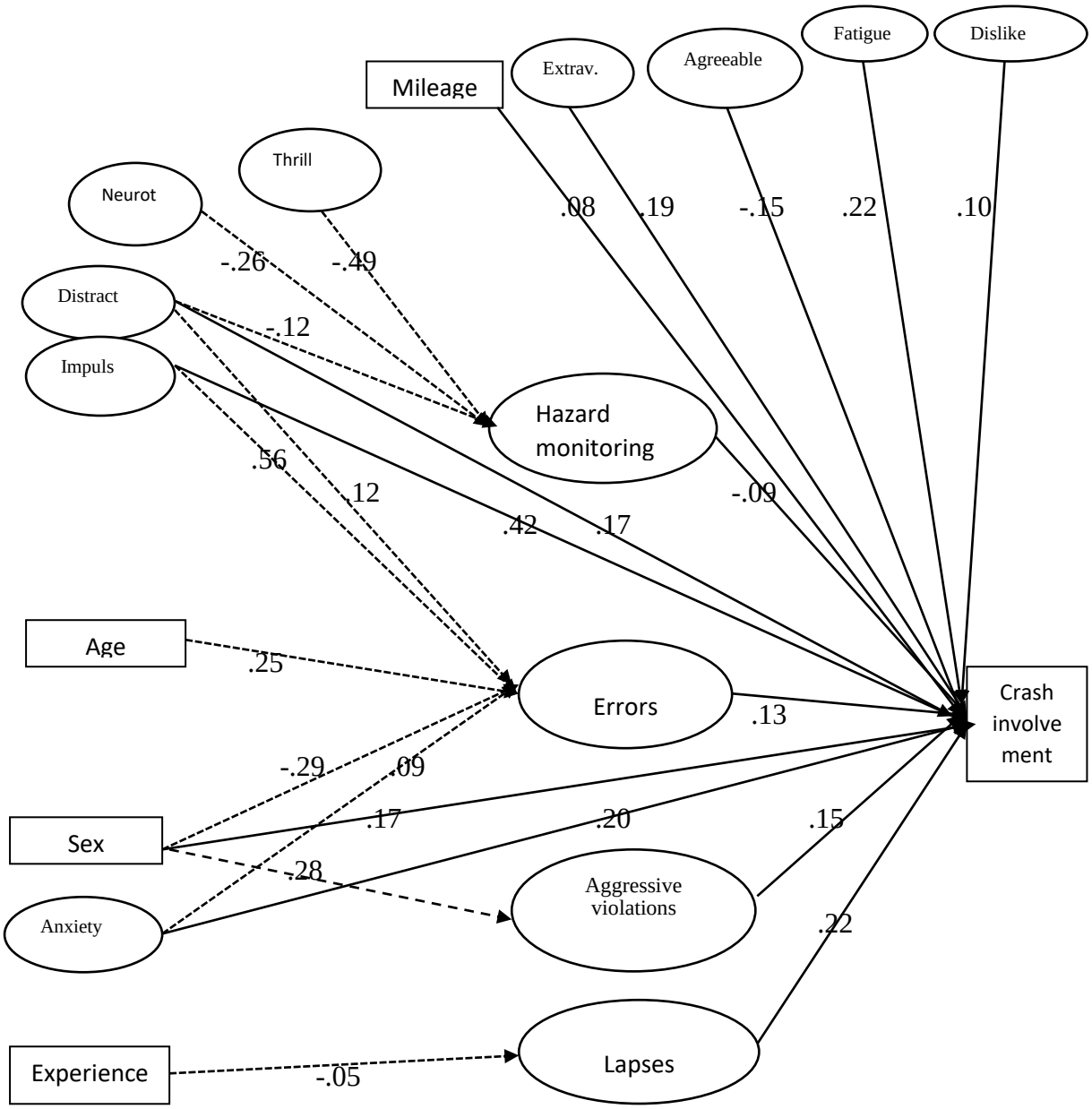

Fig.4.5 Path diagram: mediation model for the prediction of crash involvement from distal factors via proximal factors in UK. Note: Indirect paths are shown in dotted lines. Only significant paths are shown.

Table 4.5a Models (direct and indirect) of the effects of distal factors on crashes via proximal/behavioural factors (hazard, violations, errors and lapses) for Ghana and UK

	Hazard Monit.	**Violations**	**Errors**	**Hazard**	**Ord. Viol**	**Aggress Viol.**	**Errors**	**Lapses**
	GH	GH	GH	UK	UK	UK	UK	UK
Anxiety								
Direct effect	-.11*	**.47*** **	**.13***	-.10	.08	.22**	**.09***	.18*
Indirect effect (95% CI)	-.01 (-.02, .01)	**.04** (.01, .05)**	**.07** (.02, .11)**	.00 (-.00, .00)	.00 (-.02, .02)	.01 (-.00, .01)	**.12** (.04, .47)**	.00 (-.01, .02)
Total effect	-.11	**.51*** **	**.20****	-.10	.08	.23**	**.21****	.18
Impulsivity								
Direct effect	-.42***	.06	.11*	-.33***	.13	.02	**.56****	.37**
Indirect effect	.03** (.01, .04)	.00 (-.01, .01)	.01 (-.01, .02)	.00 (-.01, .00)	.00 (-.01, .01)	.00 (-.00, .00)	**.10* (.01, .12)**	.00 (-.01, .00)
Total effect	-.39***	.06	.12	-.33***	.01	.02	**.66*** **	.37
Extraversion	na							
Direct effect	na	.04	.02	-.13**	.15*	.09	.18**	.09
Indirect effect	na	.00 (-.01, .01)	.00 (-.01, .01)	.00 (-.00, .01)	.00 (-.01, .01)	.00 (-.01, .02)	.01 (-.00, .02)	.00 (-.01, .00)
Total effect	na	.04	.02	-.13**	.15*	.09	.07	.09
Agreeableness								
Direct effect	na	-.07*	-.16**	na	-.14*	-.12	-.18**	na
Indirect effect	na	-.00 (-.01, .01)	.00 (-.01, .02)	na	-.00 (-.01, .01)	-.01 (-.02, .01)	-.02 (-.06, .01)	na
Total effect	na	-.07	-.16**	na	-.14	-.13	-.20**	na
Conscientiousness								
Direct effect	na	na	-.39***	na	na	na	na	na
Indirect effect	na	na	-.01 (-.05, .03)	na	na	na	na	na
Total effect	na	na	-.40***	na	na	na	na	na
Neuroticism								
Direct effect	-.11*	.12*	.14*	**-.26*** **	.02	.19**	.19**	na
Indirect effect	.01 (-.01, .02)	.00 (-.01, .02)	.00 (-.01, .00)	**.14** (.09, .43)**	.00 (-.01, .02)	.01(-.03, .01)	.08 (-.02, .00)	na
Total effect	-.10*	.12*	.14*	**-.12****	.02	.20**	.27**	na
Openness								
Direct effect	na	-.01	-.09*	.19**	-.01	-.05	na	na
Indirect effect	na	-.00 (-.01, .02)	-.00 (-.01, .01)	-.01 (-.01, .01)	-.00 (-.00, .01)	-.00 (-.02, .01)	na	na
Total effect	na	-.01	-.09*	-.20**	-.01	-.05	na	na

** p <.05, ** p <.01, ** *p <.001*
95% CI (confidence interval, based on 10,000 bias-corrected bootstrapped samples)
N (GH = 478, UK = 404)
NA = Not Applicable
Significant mediation effects are in bold phases

Table 4.5b Models (direct and indirect) of the effects of distal factors on crashes via crash risks (hazard, violations, errors and lapses) for Ghana and UK

	Hazard monit.	**Violations**	**Errors**	**Hazard**	**Ord. Viol**	**Aggress Viol.**	**Errors**	**Lapses**
	GH	GH	GH	UK	UK	UK	UK	UK
Fatalistic Beliefs								
Direct effect	na	**.11****	**.22*****	na	-.07	.01	na	na
Indirect effect (95% CI)	na	**.04** (.01, .03)**	**.07* (.01, .04).**	na	-.02 (-.00, .00)	.00 (-.00, .01)	na	na
Total effect	na	**.15***	**.29*****	na	-.09	.01	na	na
Risk perception								
Direct effect	**.15****	**-.10****	-.02	.10*	-.02	-.14*	-.03	-.03
Indirect effect	**-.05* (-.02, -.01)**	**-.09** (-.02, -.22)**	-.00 (-.01, .01)	-.00 (-.01, .00)	-.00 (-.01, .01)	-.00 (-.00, .01)	-.00 (-.00, .00)	-.00 (-.00, .00)
Total effect	**.10***	**-.19****	-.02	.10	-.02	-.14	-.03	-.03
Aggression								
Direct effect	na	**. 20****	.03	na	.14*	.02	.06	.01
Indirect effect	na	**.11** (.03, .32)**	.00 (-.01, .01)	na	.01 (-.00, .00)	.00 (-.01, .01)	.00 (-.01, .00)	.00 (-.00, .00)
Total effect	na	**.31****	.03	na	.15*	.02	.06	.01
Dislike for driving								
Direct effect	na	.10*	.14*	-.17**	.01	.06	.08	.13*
Indirect effect	na	.00 (-.01, .01)	.00 (-.01, .01)	.00 (-.00, .01)	.00 (-.01, .01)	.00 (-.01, .01)	.00 (-.00, .00)	.00 (-.00, .00)
Total effect	na	.10	.14*	-.17**	.01	.06	.08	.13*
Fatigue								
Direct effect	na	**.19*****	**.16***	na	.27***	.18**	.13*	.07
Indirect effect	na	**.16** (.02, .04)**	**.08* (.01, .04)**	na	.00 (-.01, .01)	.00 (-.01, .02)	.00 (-.01, .00)	.00 (-.00, .00)
Total effect	na	**.35*****	**.24****	na	.27***	.18**	.13*	.07
Thrill seeking								
Direct effect	na	.06	.17**	**-.49*****	.22**	.09	.03	.10
Indirect effect	na	.00 (-.01, .01)	.11** (.01, .03)	**.04* (.01, .02)**	.01 (-.01, .01)	.01 (-.00, .01)	.00 (-.00, .00)	.00 (-.00, .00)
Total effect	na	.06	.28***	**-.45*****	.23	.10	.03	.10
Distraction								
Direct effect	**-.19***	.10*	**.21****	**-.12***	.28***	.03	**.12****	.18*
Indirect effect	**-.11* (-.02, -.08)**	.00 (-.01, .01)	**.09* (.01, .05)**	**-.10* (-.02, -.03)**	.00 (-.01, .01)	.00 (-.01, .01)	**.11* (-.00, .01)**	.03 (-.01, .00)
Total effect	**-.30*****	.10*	**.30*****	**-.22****	.28***	.03	**.23****	.21**

** p <.05, ** p <.01, ** *p <.001*
95% CI (confidence interval, based on 10,000 bias-corrected bootstrapped samples)
N (GH = 478, UK = 404)
NA = Not Applicable
Significant mediation effects are in bold phases

Table 4.5c Models (direct and indirect) of the effects of distal factors on crashes via crash risks (hazard, violations, errors and lapses) for Ghana and UK

	Hazard monit.	**Violations**	**Errors**	**Hazard**	**Ord. Viol**	**Aggress Viol.**	**Errors**	**Lapses**
	GH	**GH**	**GH**	**UK**	**UK**	**UK**	**UK**	**UK**
Maintenance								
Direct effect	.10*	**.22*** **	**.13****	na	-.10	-.22**	na	na
Indirect effect (95% CI)	.01(-.02, .02)	**.06* (.02, .04)**	**.04* (-.02, -.01)**	na	-.00 (-.00, .00)	-.00 (-.01, .02)	na	na
Total effect	.09*	**.28*** **	**.17***	na	-.10	-.22**	na	na
Age								
Direct effect	na	**-.15***	.01	na	-.31***	-.13*	**.25*** **	.35***
Indirect effect	na	**-.04* (-.03, -.01)**	.00 (-.01, .01)	na	-.03 (-.23, -.07)	-.10 (-.11, .03)	**.09**(.09, .27**	-.02 (-.02, .06)
Total effect	na	**-.19****	.00	na	-.34***	-.23**	**.34****	.33***
Sex								
Direct effect	-.02	.05	-.02	na	.26**	**.28****	**-.29*** **	-.22*
Indirect effect	.01(-.35, .24)	.02 (-.06, .09)	-.03 (-.04, .03)	na	.01 (-.13, 3.89)	**.21** (.19, 3.00)**	**-.14** (-.30, -4.22)**	-.02 (-.88, 3.90)
Total effect	-.01	..07	-.05	na	.27**	**.49*** **	**-.43*** **	-.24**
Mileage								
Direct effect	**-.24*** **	**.20*** **	**.20*** **	na	.02	.00	.02	.03
Indirect effect	**.05* (-.24, -.03)**	**.06***(.05 .25)**	**.07* (.01 .19)**	na	.00 (-1.12, .89)	.00 (-.82, .97)	.00 (-1.23, 1.00)	.01 (-.91, 1.29)
Total effect	**-.19****	**.26*** **	**.27****	na	.02	.00	.02	.04
Experience								
Direct effect	.01	.03	-.15**	.21**	.27***	.10	-.13	**-.24****
Indirect effect	-.00 (-.01, .01)	.01(-.01, .02)	-.01(-.02, .01)	-.01 (-01, .04)	.03 (-.07, .01)	.08 (-06, .21)	-.02 (-.05, .02)	**-.05* (-.11, .00)**
Total effect	.01	.04	-.16**	.20**	.29***	.18*	-.15*	**-.29****

** p <.05, ** p <.01, ** *p <.001*
95% CI (confidence interval, based on 10,000 bias-corrected bootstrapped samples)
N (GH = 478, UK = 404)
na = not applicable
Significant mediation effects are in bold phases

4.3.6 Driving test authenticity and bribery in Ghana compared to UK

Approximately 10.5% of the sample surveyed in Ghana indicated not passing a driving test before being issued with a licence. In the Ghanaian sample, 36.6% indicated they sometimes bribed police and traffic law enforcement officers, 13.0% often bribed the police and 13.8% almost always engaged in bribery. Thirty-six per cent reported never bribing a law enforcement officer. In comparison, the majority (99.5%) of the UK sample indicated never bribing police/law enforcement officers while 1 (.2%) reported he/she sometimes does and 1 (.2%) other indicated he/she often bribes law enforcement officers. In Ghana bribery related significantly with violations ($r= .31$, $p<.01$), errors ($r = .37$, $p<.01$) and crash involvement ($r = .29$, $p<.01$). Similarly, taking a driving test prior to being issued with a driving licence related to violations ($r= -.22$, $p<.01$), errors ($r = -.18$, $p<.01$) and crash involvement ($r = -.06$, $p<.05$). Bribery and driving test experience did not relate to hazard monitoring in Ghana ($p>.05$) and did not relate to any of the proximal factors in the UK.

4.3.7 Between Country (Ghana vs UK) comparison of DBQ items and crash rates

Given the differences in factor structure of the DBQ across Ghana and the UK, comparisons between countries were conducted at the item level. One-way analysis of covariance adjusting for age, sex, average weekly mileage and experience results for the between Ghana and UK (See Table 4.6) show higher scores for Ghana on 11 violations items and 12 error/lapses items (with medium to large effect sizes). Non-significant differences were found for the items on drink-driving in addition to 3 error and lapses items (realise that you have no clear recollection of the road along which you have just been travelling, forget where you left your car in a car park, and intending to drive to destination A, you ‘wake up’ to find yourself on the road to destination B). The item misread the signs and exit from a roundabout on the wrong road was estimated higher for the UK than Ghana. A further set of analyses added the distal factor scale

scores as additional covariates in the UK-Ghana comparison. As shown in Table 4.6 these additional covariates reduced the differences between UK and Ghana for 19 of the DBQ items. For example, the effect size for ‘Disregard the speed limit on a motorway’ controlling for the demographic covariates reduced from .14 to .03 when the distal covariates; anxiety, agreeableness, neuroticism, openness, and thrill were introduced into the model. However, where national differences existed prior to introducing the distal factors as covariates, the covariate introduction rarely fully removed the national difference. So there must also be other factors that explain the differences in driver behaviour observed between UK and Ghana.

Table 4.6: ANCOVA results comparing mean levels of the DBQ items between Ghana and the UK

DBQ item	Unadjusted means GH (n = 478)		UK (n = 404)		Control: Age, sex, mileage, experience		Control all distal factors		Significant Covariates
	Mean	SD	Mean	SD	*F*	*Eta²*	*F*	*Eta²*	
17-Become angered by another driver and give chase with the intention of giving him/her a piece of your mind	1.68	1.66	.28	.82	219.24***	.20	92.32***	.10	1,2,6,7,8, 11,12,13,14,15
21-Race away from traffic lights with the intention of beating the driver next to you	1.93	2.03	.76	1.17	107.03***	.11	15.49***	.02	1,2,8,10,12,13,15
16-Attempt to overtake someone that you had not noticed to be signaling a left turn	1.36	1.70	.24	.78	134.03***	.14	27.36***	.03	1,2,3,6,7,8,12,15
28-Disregard the speed limit on a motorway	2.81	1.87	1.16	1.45	145.34***	.14	23.40***	.03	1,4,6,7,10,13
25-Become angered by a certain type of a driver and indicate your hostility by whatever means you can	2.21	1.55	.86	1.26	157.47***	.15	88.47***	.10	1,2,3,8,10,15
11-Disregard the speed limit on a residential road	2.52	2.20	.91	1.12	127.63***	.13	28.23***	.03	1,3,5,6,7,10,13,15
7-Sound your horn to indicate your annoyance to another road user	2.86	1.50	.85	1.05	388.69***	.31	102.69***	.11	1,2,3,10
24-Cross a junction knowing that the traffic lights have already turned against you	1.65	2.09	.57	.90	99.04***	.10	19.63***	.02	1,2,3, 7,8,9,12,13,14,15
15-Attempt to drive away from the traffic lights in third gear	1.52	2.12	.59	1.00	66.33***	.07	.803**	.10	1,2,3,7,8,9,11,12,13,14,15
23-Drive so close to the car in front that it would be difficult to stop in an emergency	1.69	2.06	.50	.87	124.02***	.13	24.00***	.03	1, 3,7, 8, 11, 12, 15
10-Pull out of a junction so far that the driver with right of way has to stop and let you out	2.36	2.29	.63	.96	160.40***	.16	39.76***	.05	1,3,5,6,7,10,12,13,14,15
18-Stay in a motorway lane that you know will be closed ahead until the last minute before forcing your way into the other lane	1.90	2.05	.42	.90	171.40***	.17	72.00***	.08	1,2,3,6,7,8,11,12,13,14,15
27-Underestimate the speed of an oncoming vehicle when overtaking	1.82	2.05	.50	.94	146.81***	.15	28.92***	.03	1,2,3,7,8,12,13,14,15
9-Brake too quickly on a slippery road or steer the wrong way in a skid	2.46	2.19	.38	.77	270.10***	.24	105.02***	.11	1,3,6,7,10,11,12,15
14-Miss “Give Way” signs and narrowly avoid colliding with traffic having right of way	2.38	1.93	.28	.80	321.25***	.27	70.79***	.08	1,2,3,8,10,12,15
8-Fail to check your rear-view mirror before pulling out, changing lanes	2.64	2.29	.60	1.01	198.17***	.19	35.35***	.04	1,3,5,7, 11,13, 14
26-Realise that you have no clear recollection of the road along which you have just been travelling	.71	1.11	.97	1.15	3.47	.00	.05	.00	2,3,4,11
12-Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers	.93	1.34	.62	1.00	13.35***	.02	.11	.00	1,5,7,8,11,12,14, 15
6-Fail to notice that pedestrians are crossing when turning into a side street from a main road	1.35	1.49	.41	.95	84.34***	.09	2.39	00	1,2,3,4,8
22-Misread the signs and exit from a roundabout on the wrong road	.71	1.11	1.00	1.12	6.19*	-.01	2.04	.00	2, 4, 11,13
19-Forget where you left your car in a car park	1.00	1.58	1.03	1.20	1.36	.00	1.12	.00	1,2,8, 12,15
20-Overtake a slow driver on the inside	1.88	1.46	.65	.90	141.31***	.14	24.19***	.03	1, 4,5,6
13-On turning left/right nearly hit a cyclist who has come up on your inside	1.39	1.64	.27	.79	113.01***	.12	16.52***	.02	1,2,8,15
4-Get into the wrong lane approaching a roundabout or a junction	2.05	2.30	1.12	1.12	55.99***	.06	13.11***	.02	2,3,6,7,8,11,14,15
5-Queuing to 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	.74	1.12	.46	.88	27.55***	.03	30.59***	.04	1,2,3,4,5,7, 10,11,14
1-Hit something when reversing that you had not previously seen	.72	.84	.29	.77	37.67***	.04	15.68***	.02	2,5,15
2-Intending to drive to destination A, you “wake up” to find yourself on the road to destination B	.41	.86	.50	.96	2.13	.02	.20	.00	2,5,7
3-Drink and drive	.39	.84	.32	.96	.21	.00	16.57***	.02	2,5,7,8,9,12

*$p < .05$, **$p < .01$, ***$p < .001$,

Means for UK differ between 397 and 404 samples

Distal covariates: 1=anxiety, 2=impulsivity, 3=extraversion, 4=agreeableness,5=conscientiousness, 6= neuroticism, 7=openness, 8=fatalistic beliefs, 9=risk perception, 10=aggression, 11=dislike for driving, 12= fatigue, 13=thrill, 14=distraction, 15=maintenance.

We investigated national differences in crash involvement using logistic regression. Country was entered at step 1, demographic factors were entered at step 2, latent distal factors that were worse in Ghana (e.g., anxiety, distraction and belief) were entered at step 3, and the remaining distal factors were entered at step 4. As shown in Table 4.7, Ghanaians were at significantly higher risk of crash involvement than UK drivers after controlling demographic factors. When controlling for the distal factors that were significantly worse in Ghana, the national comparison was non-significant. When controlling for all observed and latent distal predictors, however, being a Ghanaian was associated with higher crash involvement.

Table 4.7 Logistic regression models predicting differences in crash rates by country from distal factors and hazard monitoring

	Odds ratio (95% Confidence Interval)			
	Crash involvement			
Variable	Step 1 country	Step 2 demographics	Step 3 Distal factors worse in Ghana	Step 4 all distal factors
Country	1.42* (1.07-1.89)	1.78** (1.24-2.55)	1.26 (.77-2.06)	2.97**(1.51-5.86)
Age		1.00 (.98-1.01)	.99 (.97-1.01)	.99 (.98-1.01)
Sex		.74 (.51-1.07)	.73 (.50-1.07)	.75 (.50-1.12)
Experience		1.01 (1.00-1.03)	1.02* (1.00-1.04)	1.02* (1.00-1.04)
Mileage		1.60***(1.41-183)	1.30*** (1.13-1.51)	1.14 (.97-1.34)
Anxiety			.97 (.91-1.02)	.93* (.87-.99)
Fatalistic Beliefs			1.03** (1.01-1.05)	1.02 (1.00-1.05)
Distraction			1.08*** (1.05-1.12)	1.07**(1.02-1.11)
Impulsivity				1.04* (1.01-1.07)
Extraversion				1.12** (1.05-1.20)
Agreeableness				.84*** (.77-.93)
Conscientiousness				1.08 (.97-1.19)
Neuroticism				1.07*(1.00-1.15)
Openness				1.06 (.98-1.15)
Risk perception				1.01 (.96-1.06)
Aggression				.98 (.94 -1.02)
Dislike for driving				1.06** (1.05-1.02)
Fatigue				1.03 (.99-1.07)
Thrill seeking				.99 (.95-1.03)
Maintenance				1.01 (.94-1.09)

** p < .05*
*** p < .01*
**** p < .001*
Sex (female = 0, male = 1), country (Ghana = 1, UK = 0).

4.3.8 Effect of driver category (commercial and private) on DBQ factors in Ghana

To test whether driver category was linked to violations, and errors in Ghana a hierarchical multiple regression predicting the DBQ factors (violations and errors) from driver category was conducted (Table 4.8).

Table 4.8 Summary of Hierarchical Regression Analyses of driver category predicting DBQ factors in Ghana

	Viol						Errors					
	Step 1			Step 2			Step1			Step2		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SEB*	*β*
Age	-.32	.16	-.16*	.29	.16	.14	.18	.04	.31***	.18	.04	.31***
Sex	.19	.33	.02	7.5	5.37	1.00	-.79	.91	-.04	-.53	1.48	-.03
Mileage	10.15	.86	.49***	10.15	.85	.49***	2.75	.24	.48***	2.75	.24	.48***
Experience	-.65	.18	-.28***	-.62	.18	-.26**	-.25	.05	-.38***	-.25	.05	-.38***
Category				-6.04	4.51	-.29**				-.27	1.24	-.25**
R^2	.06*			.19*						.09		.30
ΔR^2				.13*								.21**
F for ΔR^2				45.14*								28.39*

*n = 478, *p < .05, **p < .01, ***p < .001,*
Sex (female = 0, male = 1), driver category (commercial car driver = 1, private car drive =2).

Table 4.8 shows that the socio-demographic factors (age, sex, mileage and experience) explained 6.7% of the variance in violations (Step1). When entered at step 2, driver category significantly predicted violations ($\Delta \boldsymbol{R^2} =$ .13, [F (5, 439) = 45.14, $p < .05$]) such that being a commercial driver is associated with more frequent violations. Similarly the socio-demographic factors explained 9.4% of the variance in errors (Step1). When entered at step 2, driver category significantly predicted errors ($\Delta \boldsymbol{R^2} =$ .21, [F (5, 439) = 38.39, $p < .05$]) such that being a commercial driver is associated with more frequent errors.

4.3.9. Association of driver category with crash involvement

We investigated the associations *of driver category with* self-reported crash involvement using logistic regression with a hierarchical approach. Age, sex, mileage, and experience (years in driving) were treated as covariates in the model. The socio-demographic variables

were entered at the first step and the driver category (commercial and private) entered at the second step.

Table 4.9 Logistic regression model of the association between driver category and crash involvement in Ghana

	Odds ratio (95% Confidence Interval)	
	Crash involvement	
Variable	Step 1	Step 2
Age	1.02 (.99-1.05)	1.02 (.99-1.05)
Sex	.85 (.44-1.64)	.57 (.21-1.56)
Experience	.97(.94-1.01)	.97 (.94-1.01)
Mileage	1.91*** (1.61-2.27)	1.91*** (1.61-2.28)
Driver category		1.54***(.67-3.52)

*** $p < .001$
Sex (female = 0, male = 1), Driver category (commercial car driver = 1, private car drive =2),

As shown in Table 4.9, only mileage significantly predicted crash involvement at step 1 while age, sex and experience did not. At step 2 driver category was a significant additions to the model predicting crash involvement. Mileage remained a significant predictor but no other demographic variable was significant.

4.3.10 Logistic regression model predicting crash involvement from ordinary violations in the UK

In the UK, ordinary violations did not predict crash involvement in the mediation model. Therefore, the independent contribution of ordinary violations to self-reported crash involvement using logistic regression was investigated for the UK sample. The demographic variables; age, sex, mileage, and experience in addition to other DBQ factors; aggressive violations, errors and lapses were treated as covariates in the model employing a formal hierarchical approach. All continuous predictors were standardised (z-scores) so that associations are presented as the odds ratios for a 1 standard deviation increase. The demographic covariates were entered at step 1, ordinary violations were entered at step 2,

aggressive violations, errors and lapses were entered at step 3, and hazard monitoring entered at step 4.

Table 4.10 Logistic regression model predicting crash involvement from ordinary violations in the UK

	Odds ratio (95% Confidence Interval)			
Variable	Step 1	Step 2	Step 3	Step 4
Age	.98 (.96-1.00)	.99 (.96-1.01)	.99 (.97-1.01)	.99 (.97-1.01)
Sex	1.33* (.85-2.09)	1.42* (.88-2.26)	1.43* (.89-2.27)	1.43* (.89-2.27)
Experience	1.04**(1.02-1.06)	1.03** (1.01-2.06)	1.03** (1.01-1.06)	1.04** (1.01-2.05)
Mileage	1.11** (.89-1.38)	1.07** (.86-1.34)	1.08** (.86-1.34)	1.07** (.86-1.34)
Ordinary violation		**1.48**(1.27-2.96)**	**1.10*(1.08-1.69)**	**.97 (.95-1.06)**
Aggressive violations			1.99***(.96-2.27)	1.14***(1.09-2.19)
Errors			.98 (.91-1.09)	1.05** (.98-1.09)
Lapses			1.00 (.95-1.06)	1.66**(1.05-2.09)
Hazard monitoring				1.14** (1.02-2.05)

** p < .05*
*** p < .01*
**** p < .001*
Sex (female = 0, male = 1)

As shown in Table 4.10 ordinary violations independently predicted crash involvement in step 2. In step 3, the two violations; ordinary and aggressive predicted crash involvement with decreased effect for the ordinary violations between step 2 and 3. When hazard monitoring was introduced into the model in step 4, the ordinary violations turned non-significant.

4.4 Discussion

This study tested a model of the processes underlying risky driving behaviours in Ghana and compared them to the processes underlying risky driving in the UK. The revised hypothesised Contextual Mediated Model proposed that distal factors; personality (e.g., impulsivity, and extraversion), beliefs, attitudes (e.g., risk perception, distracted driving and maintenance practices), stress, anxiety and socio-demographic variables (e.g., sex, age, mileage and experience) would predict crash involvement either directly or indirectly through a set of proximal driving behaviour factors; hazard monitoring, violations, errors

and lapses. Exploratory and confirmatory factor analyses showed that the 24 item 2-factor structure DBQ in Ghana derived in Chapter Three was supported in this independent data set. A four-factor structure with sub-divisions within the violations; ordinary and aggressive, and lapses separated from the errors factor was observed for the UK sample as is consistent with existing UK DBQ analyses (e.g., Lajunen et al., 2004).

4.4.1 Proximal factors (crash risks) and crash involvement

Path modelling results showed the relationship between distal factors and crash involvement was mediated by proximal factors in both settings. The proximal factors tested in Ghana; hazard monitoring, violations and errors significantly predicted crash involvement while 4 of the 5 proximal factors identified for the UK; hazard monitoring, aggressive violations, errors and lapses predicted crash involvement in the mediation model. The relationship found between the behavioural risks and crash involvement from both Ghana and the UK are generally congruent with many existing studies (e.g., de Winter & Dodou, 2010) that have demonstrated that the components of the DBQ are good predictors of crash involvement.

In the present UK sample, ordinary violations taken together with other crash risks in a mediation model did not relate significantly to crash involvement. The simple correlation between the ordinary violations and crash involvement was significant with an estimated coefficient of .12 which is compatible with the association of .13 estimated in De Winter et al.'s (2015) meta-analyses. A hierarchical regression analysis (see table 4.10) showed that the demographic variables did not explain the association between ordinary violations and crash involvement. The effect was explained, by the other DBQ scales and hazard monitoring that predicted crash involvement in the hierarchical model. It may be that poor

hazard monitoring is a proxy for a generally risky driving style that is also measured by the ordinary violations scale of the DBQ.

The results point to an important role of hazard monitoring in crash involvement in both settings, highlighting that this effect is independent of the correlation of hazard monitoring and errors and violations. This indicates that hazard monitoring may be measuring a construct involved in driving risk that is independent of choosing risky driving styles (violations) and from making mistakes while driving as indexed by the errors construct in the DBQ (Boufous, Ivers, Senserrick, & Stevenson, 2011; Cheng, Ng, & Lee, 2011). One possibility is that the measure goes some way to tapping hazard perception skills that have most often been assessed in video-based tests (Wetton, Hill, & Horswill, 2011). This raises an issue of whether differences exist in hazard skills assessment via questionnaire and simulations. In most cases, simulations are thought of being better at assessing hazard skills (Wetton et al., 2010). But it is also argued that simulation measures what people can do, whereas a questionnaire reflects what they choose to do in driving (i.e., how much effort they put into monitoring during driving) as such simulations in driving may have validity issues (Godley, Triggs, & Fildes, 2002; Reimer et al., 2006). Alternatively, the cross-sectional nature of these data may limit the strength of the conclusions that can be made on this point. As crash involvement is assessed retrospectively, it is possible that drivers who have been involved in crashes infer from this experience that their hazard monitoring is poor. Therefore, longitudinal data will be required to further test the direction of effect between self-reported monitoring and crash involvement.

4.4.2 Anxiety and driver crash risks

The results showed that in Ghana, a combination of violations and errors fully mediated the relationship between anxiety and crash involvement as expected. That is violations and

errors increase with increasing anxiety resulting in crashes. In the UK the path from anxiety to crash involvement was partially mediated by errors but not violations and anxiety related both directly and indirectly to crashes. The link from anxiety to crashes through errors for the UK sample is consistent with existing Western literature (Matthews, 2001, 2002). Vulnerability to stress that leads to errors among highly anxious drivers were the explanations offered for the relationships (Matthews, 2001, 2002). Working pressures and demands that often lead to higher anxiety reported among the most important group of drivers in Ghana with respect to crash involvement; commercial drivers (see Chapter Two) could explain the differences in the mediation links between Ghana and the UK.

4.4.3 Personality factors and driver crash risks

In the Ghana impulsivity related both directly and indirectly through hazard monitoring to crashes (partial mediation) but there was no mediation via violations or errors. One possibility is that hazard monitoring is impaired at higher levels of impulsivity. In the UK the path from impulsivity to crash involvement was partially mediated by errors, as expected. The link to crashes from impulsivity through errors for the UK sample is supported by Western literature (Matthews, 2001, 2002) and could be attributed to vulnerability to stress (Matthews, 2001, 2002).

In Ghana, of the big-five personality factors; agreeableness and conscientiousness had direct effect on crashes, while in the UK extraversion and agreeableness related to crash involvement directly. In Ghana, violations partially mediated the path between aggression and crash involvement. In the UK, neuroticism related indirectly to crash involvement through hazard monitoring. The findings are largely consistent with other studies (e.g., Lucidi et al., 2010; Ulleberg and Rundmo, 2003). Stronger path coefficients for the indirect

effects of personality to risky driving behaviours (mediators) than the direct effects of personality on crash involvement were observed, indicating that the majority of the relationship between personality and crash involvement is explained by variation in driving behaviour. These patterns of effects were similar to those observed in Sumer's model (Sumer, 2003). In Sumer's model, personality factors predicted crash involvement via their effects on driving behaviours. However relatively weaker path coefficients were observed between the personality factors and crash involvement than from personality to risky driving behaviours (Sumer, 2003). It is possible that the direct effect from personality to crash involvement is mediated by some form of behaviour that is not fully captured by measures in the current study, such as safety orientation/skills (Lajunen, Parker & Stradling, 1998). The results of the present study suggest personality factors are important to crash prediction in both Ghana and UK but interventions targeting reducing these effects may need to be targeted at different risky driving behaviour in each country.

In Ghana, errors fully mediated the path between thrill-seeking and crash involvement contrary to expectation. Violations and errors were both moderately correlated with thrill-seeking in Ghana (See Appendix A; Table A-2). Although they are correlated, the mediation model identified that the independent mediation involves errors rather than violations. It is often found that thrill-seeking relates to crashes through violations such as speeding (Rimmö & Åberg (2014). In our UK data, however, although there were simple correlations between thrill seeking and both errors and violations, the mediation model showed hazard monitoring fully mediated the relationship between thrill and crash involvement contrary to expectation. This implies that thrill seeking impairs the level of hazard monitoring that leads to crashes. Similar to the relationship observed in the present set of samples from both Ghana and UK, hazard monitoring correlated negatively with thrill seeking in previous studies (e.g., Öz,

Özkan, & Lajunen, 2010). The findings further demonstrate the importance of hazard monitoring in crash prediction in the UK.

4.4.4 Safety attitudes; fatalistic beliefs, risk perception and driver crash risks

Besides personality factors, the present study addressed the role of a range of attitudes; fatalistic beliefs, risk perception and maintenance practices as distal predictors of crash involvement. Most of these distal factors performed a role in Ghana but not in the UK. In Ghana, the path between fatalistic beliefs and crash involvement was partially mediated via both violations and errors. One possibility is that drivers who believe accidents are the result of supernatural forces believe that risky and careless driving will not have any implications for crash risk. Fatalistic beliefs have been found to influence work accidents in general as it has a negative influence on any form of risk assessment and risk-taking behaviours in organisations (Slovic, Fischhoff, & Lichtenstein, 1981). This factor may be more crucial to driver crash prediction in the Global South (Teye-Kwadjo, 2019). Themes of spiritual influences on crashes were prominent in the qualitative exploratory study on crash risks factors in Ghana reported in Chapter Two. Current approaches to dealing with risky driving attitudes have provided limited evidence of the efficacy of education in reducing crashes in the developed world (Poulter & McKenna, 2010), however, an education strategy may be effective in changing the beliefs held by Ghanaian motorists regarding fatalism. Beliefs about control were identified as crucial to maintaining safety in organisations in developing countries (Kouabenan, 2009).

Risk perception related indirectly to crashes through the combined effect of hazard monitoring and violations (full mediation) as expected in Ghana but not in the UK where risk perception correlated moderately with the DBQ factors but the pathways to crash involvement was not mediated. The direction of the effect in the Ghanaian data suggests that

lower perceived risk is related to higher rates of violation and lower level of hazard perception resulting in crashes. In the present study, Ghanaian drivers reported a slightly higher (small effect size) perceived risk than observed for the UK sample consistent with the higher risk of crash in Ghana compared to the UK.

Moderate positive correlations were found between distraction and DBQ factors in both Ghana and the UK while distraction related negatively with hazard monitoring. As expected, the effect of distraction on crash involvement was partially mediated by the combined effect of hazard monitoring and errors in Ghana and UK. This underscores the dangers of engaging in distracting activities while driving in both the developed and the developing world. Mobile phone use is one such distracting activity that has drawn global attention in recent times (WHO, 2011). The use of mobile devices may become more common in the Global South as economies develop. Mobile telephone penetration/subscription has seen a 113% increase between 1994 and 2014 in Ghana (National Communication Authority of Ghana, 2015). Although there are regulations (e.g., Ghana Road Traffic Regulations, 2012; L.I 2180, [Partners for Safe Driving Ghana, 2012]) that prohibit the use of mobile phones while driving in both countries, the enforcement may be less effective in Ghana compared to the UK.

4.4.5 Maintenance behaviour and crash risks

The condition of a driver's vehicle has been proposed as an important factor that can contribute to crashes (af-Wahlberg, 2004). The results of the present study show, contrary to expectation, that higher levels of maintenance practices are related to more frequent violations and errors that lead to crashes in Ghana. Thus, the path between maintenance practices and crash involvement was fully mediated via a combination of violations and errors in Ghana. These results are inconsistent with findings from the Western world that

suggest the links between maintenance and crash involvement may be direct and in the opposite direction (United States Federal Motor Carrier Safety Administration [FMCSA], 2006). Maintenance behaviour related negatively and weakly with the DBQ factors and crash involvement for the UK sample in the present study. Unlike the Western world the use of poorly maintained vehicles, mostly for commercial passenger and goods transportation, is characteristic of Ghana and other countries of the Global South. Many passenger transportation vehicles were not designed for this purpose and were modified locally into commercial passenger vehicles.

One possible explanation is that the more frequently drivers maintains their vehicles, the better the condition of the vehicle that encourages risky driving behaviour such as speeding. Another possibility is that people who are comfortable taking risks are more likely to own vehicles that are less roadworthy and therefore require the most maintenance as well as being people who are likely to have higher rates of violations and errors when driving. Either of these mechanisms could explain the path from maintenance to crashes being mediated by violations in our model.

4.4.6 Effect of stress and fatigue on driver crash risks

The components of the driver stress inventory used in the present study, including aggression, dislike for driving, fatigue, and thrill (Mathews et al., 1997), showed links with risky driving behaviours and crash involvement and were largely consistent with existing findings (e.g., Philip et al., 2010; Smith et al., 2009). In Ghana the path between fatigue and crash involvement was fully mediated by a combination of paths through violations and errors. In the UK dislike for driving and fatigue related directly to crash involvement rather than via any of the mediators. As this study is cross-sectional, the direction of effect here could mean that people who have experienced a crash enjoy driving less. No mediation path was found for the stress indices in the UK. As reported in the qualitative data in Chapter

Two and the socio-demographic information of the present study, drivers in Ghana, particularly commercial drivers, often work for more than 8 hours a day with limited rest. This may lead to the fatigue that was found to increase violations and errors leading to crashes (Haworth, 1995). Even though fatigue was rated higher in the UK data than in Ghana (see Table 4.4) the effects may be more severe in Ghana than in the UK. In the developed world such as the UK, there are regulations (e.g., tachograph rules) that prevent long working hours and therefore may mitigate the effect of fatigue on driving behaviour.

4.4.7 Socio-demographic correlates of behavioural crash risks and crash involvement

Consistent with existing evidence, demographic variables; age sex, mileage and experience emerged as significant factors in crash prediction in both Ghana and UK (de Winter & Dodou, 2010; Evans 2000). In Ghana, the path between age and crash involvement was partially mediated by violations. The direction of effect in Ghana as expected indicated that increasing age leads to decreasing violations that in turn leads to a decrease in crash involvement. This is consistent with existing evidence regarding age and violations predicting crash involvement (de Winter & Dodou, 2010). The non-significant role of errors in the age-crash involvement relationship for Ghana was unexpected based on existing literature which shows that reports of inattention errors increase with age (Aberg & Rimmo, 1998). In the UK errors mediated the path from age to predict crash involvement. Increasing age was associated with increasing errors that in turn leads to higher rates of crash involvement.

Sex related directly to crashes with males more likely to be involved in crashes in Ghana. The involvement of males in crashes could reflect exposure; one possibility is that men drive more than women in Ghana, exposing themselves to higher crash risk. However, the effect remained in the model after mileage was controlled. In the UK aggressive violations and

errors partially mediated the path between sex and crash involvement to our expectation. Effects were consistent with the evidence that suggests that males report more violations while females report more errors (de Winter & Dodou, 2010, 2016). The results of the present study indicate that the role of sex differences in predicting risky driving may not be as important in Ghana as in the developed world. Female driving in Ghana, especially for the most at risk driver group; commercial drivers is rare. It is therefore plausible that very few risk averse females choose to drive and those who do are risk-takers.

As expected, mileage predicted crash involvement directly for the UK sample with no mediation by the proximal factors, consistent with the possibility that increased exposure to driving increases crash risk. In Ghana, the relationship between mileage and crashes was fully mediated by a combination of pathways via hazard monitoring, violations and errors in Ghana. This was not expected because high mileage drivers should have more crashes simply because they are more exposed to risk. It may be that the DBQ is partly a measure of exposure because it asks for frequency of risky behaviour and this partly depends on how often you drive. However, it is not clear why this should manifest in Ghana and not the UK. The result in Ghana suggests that higher mileage impairs hazard monitoring while increasing the rates of violations and errors to predict crash involvement.

Experience (defined as years in driving) did not relate directly with crash involvement neither did it work through any of the mediators in Ghana however it related significantly with errors. In the UK, lapses fully mediated the relationship between experience and crash involvement such that higher levels of experience resulted in reduction in lapses. This is consistent with existing Western literature that found that experience reflects skill improvement and therefore error reduction (Mayhew & Simpson, 1990). Although there

were no mediation paths for Ghana, the simple correlations between experience and crash risks in the two samples were similar.

4.4.8 Mean differences in distal crash-predictors between Ghana and UK

Anxiety, fatalistic beliefs that attribute crashes to external factors, and distraction were significantly higher (with medium to large effect sizes) in Ghana compared to the UK. Conversely, fatigue was rated lower in Ghana than the UK contrary to expectation. Thrill seeking, impulsivity, neuroticism, aggression and dislike for driving were rated higher in the UK compared to Ghana. The differences in the rating of fatigue could be attributed to a number of factors including the interpretation of the items that measure fatigue relative to what one experiences. For instance, driving for longer (8hrs and more) hours is normal among commercial drivers in Ghana (see Chapter Two) therefore an item that was used to measure fatigue; *My reactions to other traffic become increasingly slow when I have to drive for several hours* may be interpreted differently among UK drivers.

4.4.9 Between countries (Ghana vs UK) comparison of proximal crash-predictors and, driving test authenticity and bribery

As in Chapter 3, we compared levels of DBQ behaviours at the item level as the composition of the factors varied between Ghana and the UK. The results show that the normal trend of the higher levels of violations and errors reported by the Ghanaian sample in Chapter 3 was replicated in the present study and the between country differences largely remained the same after controlling for age, sex and mileage. Hazard monitoring was rated lower and had stronger direct path (bigger path co-efficient) to crash involvement in Ghana than in the UK, further demonstrating risks of crashes for the Ghanaian drivers. The stronger effect for hazard monitoring in Ghana could be due to the road environment being more dangerous; presence of road obstacles such as animals crossing and pedestrians and cars

sharing the road (see Chapter Two). The between country differences remained significant after all the measured distal factors had been accounted for. The effect size estimates for the majority of the DBQ items was reduced after the adjustment. The reduction in the effect size estimates for all the control factors implies that a portion of the between countries difference was due to differences in the distal factors. Drink-driving is higher in Ghana than the UK, but there are some covariates that correlate positively with drink-driving that were higher in the UK than Ghana (e.g., dislike for driving, fatigue and thrill seeking). In the other cases risk was higher in Ghana than the UK, but the covariates were also higher in Ghana than the UK. Anxiety, fatalistic beliefs, distraction were commonly found to be the most important distal covariates that predicted the DBQ items and adjusted the effect sizes between Ghana and UK after their control (see Table 4.4, Chapter Four).

The greater frequency of violations and errors for Ghanaian drivers compared to UK drivers was expected. This is consistent with a study that classified European countries into safe and dangerous traffic cultures (Ozkan et al., 2006). There are marked differences in traffic culture between Ghana and the UK. Ghana and other countries of the Global South share many of the characteristics of 'dangerous' countries identified by Ozkan et al. (2006) including lack of respect for traffic safety rules, challenges with enforcement and less developed infrastructure. It is also possible that the traffic environment in itself, for example where vehicles and pedestrians share the road and where passengers directly interact with drivers of commercial vehicles while in motion (see Chapter Two) may make drivers in Ghana more prone to errors. Violations may be normative in Ghana in a way that they are not in the UK.

We compared crash risk in Ghana and the UK, finding that the risk of crash was somewhat higher in the Ghanaian sample. We tried including distal factors that were worse in Ghana

than the UK (anxiety, fatalistic beliefs and distraction) as covariates in this analysis and found this removed the country effect. Therefore, with several assumptions about causality, these factors might be intervention targets to reduce crash rates in Ghana; if those distal factors could be brought to similar levels to the UK then the crash rate might also become similar. Further analyses adding all the distal factors (whether worse in UK or Ghana) led to a modelled increased in Ghanaian crash risk relative to the UK that was substantially bigger than in the unadjusted model. Making Ghana totally like the UK in terms of all the distal factors studied here might make the crash situation relatively worse in Ghana. Implications for intervention are discussed in more detail in Chapter 5.

Approximately 10% of Ghanaian drivers surveyed reported not passing a driving test prior to being issued with licences to drive and that could imply the licences were obtained by bribery. Bribery was commonly reported in Ghana but extremely rare in the UK (0.1%). These results were expected and consistent with the previous findings reported in Chapter Two that identified enforcement weaknesses including corruption that encourage the entry of unskilled drivers into commercial driving. Existing evidence indicated corruption in road traffic law enforcement may be more problematic in the Global South (Nantulya & Reich, 2002).

4.4.10 Effect of driver category (commercial and private) on crash risks and crash involvement in Ghana

Being a commercial driver was associated with more frequent, violations, errors and crash involvement. This result was expected and could be attributed to a more dangerous driving. The push factors identified from the qualitative study (e.g., working conditions) that are faced by the commercial drivers in Ghana further make them prone to aberrant driving and crashes. In Malaysia, higher crash rates attributable to risky driving were recorded for

commercial bus drivers although they constitute just about 2.1% of all registered vehicles in that country (Oluwole, Rani, & Rohani, 2015).

4.4.11Limitations

There are some limitations to this study. First, this study was correlational; thus, causal inferences cannot be made. Although longitudinal data allow some stronger inferences concerning time ordering of variable associations, causal statements would still not be certain. More complex quasi-experimental designs (Jaffee, Strait, & Odgers, 2012) may be possible to strengthen the causal evidence base. Second, common-method variance as indicated in the initial quantitative study (see Chapter Three) may have contributed to prediction across exogenous and mediator variables as the data were based on self-reports. Given the nature of the problem studied, and particularly the context of the Global South, it was not possible to obtain objective information on crashes or driving behaviour. However, further work validating the DBQ with objective crash measures in the Global South and with larger samples would be advantageous.

Another observation that relates to the self-reported nature of the data for the study is with the measurement of hazard monitoring. This concept is typically measured through video simulations (Pelz & Krupat, 1974; Underwood, Crundal, Chapman, 2011; McKenna & Crick, 1994). However, the self-report measure of hazard monitoring was effective in predicting the dimensions of the DBQ in a validation study (Mathews et al., 1997) and was associated with crash involvement in the present study. Positive correlations have also been found between simulations and self-reported data taken on driving behaviours in general; speeding, weaving between traffic, passing and behaviour at stop signs (e.g., Reimer, D'Ambrosio, Coughlin, Kafrissen, & Biederman, 2006).

The balance between achieving sample representativeness of each driving population, and sample equivalence between driver groups was a challenge in the present study. Some demographic variables in some analyses were controlled to mitigate the effect on the results. There were competing demands of representativeness and equivalence of samples from the two different cultures (Ghana and the UK) however such challenges are common with cross-cultural research (He & van de Vijver, 2012). Differences in driver behaviour might be attributable to differences in local culture between Ghana and the UK, and might reflect the contrast in driver status between the two countries (with Ghanaian samples predominantly comprising of commercial/professional drivers (see Table 4.1) and the UK sample largely made up of non-commercial drivers. Differences in the understanding of the DBQ across culture could also account for the differences in driver behaviour. As such generalisation of the findings to the total population should be made with caution. The small sample size could also affect the performance of the models tested in this study. However, the results present a coherent set of findings that can inform studies with more complex designs involving laboratory measurements and simulations in the future. The self-reported data can be validated against data obtained through simulations in subsequent studies. The extent to which the present findings generalize to other developing settings with similar driving context and traffic culture should be investigated in future studies and with a larger sample.

4.4.12 Conclusion

Distal factors related to crash involvement via proximal factors in Ghana and the UK. Overall, the findings provide empirical support to the revised contextual mediated model (following Sumer, 2003) to explain driving behaviour in Ghana as well as the UK. More mediating paths were observed for Ghana than the UK despite the higher number of mediators included in the UK models. This could be attributed to the revision process of the contextual mediated model that included some factors (e.g., beliefs) likely to be more

important in the Ghanaian setting. Alternatively, the differences could also be attributed to the higher rates of violations and errors reported by the Ghanaian sample compared to the UK sample that could mean a stronger relationship among the variables in Ghana. The less regulation and enforcement in Ghana might mean that driving behaviour is more closely linked to crash involvement. Differences in the rating of many of the factors (e.g., fatigue) between Ghana and the UK could be as a result of the interpretation of the items that measure the constructs relative to what one does in actual driving.

The results from the present study suggest that the revised contextual model can partly explain the process underlying risky driving behaviours among drivers in Ghana and the UK. However, the differences in the results between the two settings show that the model may not be universal to all cultures. In comparison to the original contextual mediated model (Sumer, 2003), the present model had relatively more significant paths. The findings have implications for safety policies and interventions to alleviate road crash fatalities in the Global South. Further implications and recommendations for practice and future research are discussed in the next chapter.

Chapter 5: General Discussion

The previous chapters report three empirical studies that address the main objectives of this thesis, which were to determine the extent to which driver crash prediction models from the Western world generalises to the context of Ghana and identify behavioural risk factors that are specific to the context of Ghana. This final chapter presents a summary of the main findings and considers their collective contribution to the research base on road crash intervention in Ghana and other countries of the Global South. Interventions that may improve the road safety situation in Ghana are discussed. The implications of the studies reported as well as suggestions for future research are presented.

5.1 Summary of empirical findings

There is a growing body of literature on crash risks in the developed world, but little is known about how well these models apply to motoring in developing countries, the context in which the majority of road traffic fatalities occur. Considering the relatively unexplored nature of the topic of behavioural predictors of driver crash risks in Ghana the first study reported in Chapter 2 explored factors influencing crash risks for commercial drivers in Ghana through the use of qualitative interviews. The aim of the first study was to inform a quantitative study by providing an insight into the specific driver crash risks factors peculiar to Ghana (if any) and whether factors common in the Western literature are also relevant to the Ghanaian context. The participants identified some issues that are shared with drivers in the developed world, though moderated by the Ghanaian context. These included working pressures (e.g., fatigued driving), speeding, distracted driving and inadequate vehicle maintenance. Other factors identified by the participants are infrequently considered in research addressing driving behaviour in developed countries. These included aggressive competition for passengers between commercial drivers and corruption (e.g., improper licensing practices) among other issues. These results, in addition to the factors identified in

the Western literature presented in Chapter One, were used to revise the contextual mediated model; this posits distal factors (e.g., personality) that work through proximal factors (e.g., errors and violations) to predict crashes (Sumer, 2003) that was tested in the main study.

The second study reported in Chapter Three tested the validity of the Driver Behaviour Questionnaire (DBQ) in the Ghanaian driving culture. The aim was to determine the applicability of the 28 item version DBQ to Ghana in terms of measuring the proximal error and violation components of the contextual model in preparation for applying it in a larger scale study that can test a number of aspects of the proposed links between distal and proximal predictors of crash involvement. The measure originally developed by Reason et al. (1990) has been adapted and used in about 150 countries, mostly in the developed world. Evidence on its applicability to driving in the Global South is limited. Exploratory factor analysis was performed using one random half of the data and the confirmatory factor analysis conducted on the other half. The analyses produced a 24-item 2-factor (violations and errors) model of the DBQ for the Ghanaian Sample. Both dimensions (violations and errors) were conceptually similar to factors that are typically extracted from the DBQ, although there were some differences in loading pattern. Both violations and errors independently predicted crash involvement and correlated positively with a number of other expected external constructs including sensation seeking to demonstrate external validity. It was concluded based on the findings that the DBQ is an appropriate measure to apply in Ghana to measure aberrant driving behaviour.

Based on the literature reviewed from the Western world and factors identified from the qualitative study, the contextual mediated model of road crashes (Sumer, 2003) was revised. The third study reported in Chapter 4 tested the revised contextual model. It was aimed to

determine whether the relationships between distal factors (e.g., anxiety, driver distraction, driver stress) and crash involvement were mediated by behavioural crash risks (hazard monitoring, violations and errors). The extent to which the results from Ghana compare to the UK was determined in Chapter Four through data collection in both countries. A confirmatory factors analysis supported the 2-factor structure of the DBQ obtained for Ghana in the previous study (Chapter Two) while the commonly found 4-factor model of the DBQ was supported in the UK sample. Results of path modelling showed that distal factors related to crash involvement via proximal factors in Ghana and the UK; the framework of the contextual mediated model is appropriate to model crash risk in Ghana as in the UK. However the details of the models differ, for example in terms of which distal factors are most important in each country. Overall, the findings provided empirical support to the contextual mediated model (Sumer, 2003) to explain driving behaviour in Ghana as well as the UK.

Study II and III reported in Chapters Three and Four respectively found that aberrant driving behaviours; violations and errors are more common in Ghana compared to the UK. The Ghanaian sample reported higher levels of distal risk factors; anxiety, impulsivity, extraversion, agreeableness, conscientiousness, neuroticism, openness, fatalistic beliefs, risk perception, aggression, dislike for driving, thrill, distraction, and maintenance than the UK sample. Crash involvement was more common in Ghana that the UK. Other behaviours that could collectively be described as corruption; paying/bribing a law enforcement officers, not passing a driving test prior to being issued with a licence were identified in both the qualitative and quantitative data collected in Ghana. There was also some evidence from our study (see Table 4.1, Chapter Four) that showed that there were some unlicensed drivers and people holding licences inappropriate for the type of vehicle being driven in Ghana. Some of the commercial drivers surveyed were below the legally required age limit of 25 years

(Ghana Road Traffic Act; 683 of 2004). These behaviours were rare in the quantitative data collected in the UK and in the existing literature reviewed from the developed world.

5.2 Theoretical and Practical Implications of the findings for road safety policy and interventions

Collectively, the results presented in this thesis have theoretical and practical implications for road crash interventions and policies in Ghana and other countries of the Global South. Regarding theory, the analyses supported the framework of the contextual mediated model (Sumer, 2003) that holds that there are distal factors to crash involvement that are mediated by proximal factors. Similar to the revised Contextual Mediated Model tested in the present study other mediated models with specific theoretical underpinnings have been applied in previous driver behaviour studies. For example, the Theory of Planned Behaviour, that explains that attitude-behaviour link is mediated by behavioural intentions (Ajzen, 19991) has been applied to driving (e.g,, Dimmer & Parker, 1999; Parker et al., 1992, 1996). Differences in the crash prediction models observed between Ghana and the UK presented in Chapter Four show the need for context-specific theories and models as different countries have their own unique traffic culture and challenges aside from the risky driving behaviours (e.g., speeding) that are global (Ozkan et al., 2006). For example, fatalistic beliefs were important in Ghana but not in the UK. Such models may require revision over time to address the changing trend of motorisation especially in the Global South.

Moving beyond theory, these studies have important practical implications regarding the relationship between behavioural factors and driver crash risks in Ghana and other Countries of the Global South that are experiencing rapid economic growth. Interventions aimed at modifying and enforcing safer driving are crucial to reducing crashes in Ghana. This could

involve intervening to change attitudes, which, unlike personality traits, that are more stable across the lifespan, are somewhat flexible and context-dependent (Bohner & Dickel, 2011; Petty et al., 1997), thus, are more likely to be influenced and changed through targeted road safety interventions. In order to develop an effective programme of behaviour change interventions to reduce crash rates in Ghana, there is the need to focus on theory driven interventions that target the key modifiable determinants of each behaviour. The main reason is that current interventions are largely not theory based and largely do not work (Poulter & McKenna, 2010). Although the non-theory based interventions might not work in the west, there may be behavioural targets in Ghana (e.g., fatalistic beliefs) that are amenable to education.

While it is clear that Ghana's social and economic development would benefit from a more sophisticated road infrastructure (e.g., Ghana Transport Sector Improvement Project, 2017) the high level of errors and particularly deliberate risky driving reported in this study mean that such infrastructure improvements must be delivered with care. Currently, it is possible that conditions of the road infrastructure mitigate the potential for risky driving to translate into crashes and injuries through providing natural traffic calming features that prevent high speed travel. Therefore, improved roads may be most effectively introduced in the context of a stronger road safety culture including improved training, education and enforcement of road safety regulations. The findings have implications for building a research base to support the development of road safety policy and interventions in developing countries. This is due to the limited research on road crash intervention strategies in the Global South (Staton et al., 2016). In developed countries that have been motorised for a long time, fatalities are no longer increasing. This may be at least partly attributable to effective countermeasures.

There is a dramatic increase in crash deaths and injuries in many countries where the large scale use of motor vehicle is relatively new (Peden et al., 2001). Some of the crash countermeasures that are effective in motorised countries may be applicable in the Global South, but some of these countermeasures will need to be adapted to local traffic conditions. For example, in many less motorised countries such as Ghana, traffic use patterns; the disparate mix of road users (bicycles, commercial tricycles, commercial passenger motorbikes [‘Okada’], and pedestrians in most cases) sharing the same roads, may require traffic engineering measures that are different from those that have been successful in the developed world, where there is more homogeneity in the traffic mixes (Mohan & Tiwari, 1998, 2000; Tiwari, 1996). It is worth noting that some of the issues identified in this thesis (e.g., violations such as breaking speed limits) that would form the basis of recommendations of any kind are already intervention targets set by various stakeholders in the Ghanaian road safety (e.g., NRSC road safety strategy III targets to ensure safer road user behaviour through an integrated speed management programme and improved enforcement [NRSC, 2012]). The following recommendations for interventions are made based on the findings of the three studies.

5. 2.1 Licensing reforms

System wide interventions, including licensing reforms are needed given the evidence of the presence of unlicensed and untrained/improperly trained drivers on the Ghanaian roads found in this study. The licensing regime that currently takes a few hours to complete (DVLA, Ghana, 1999) should be redesigned to make it a better preparation for safe driving. In that regard Graduated Driver Licensing (GDL) - a multi stage driver training approach that imposes restrictions on new drivers (Foss, & Evenson, 1999; Waller, 1974) may usefully be adopted. Under GDL, individuals under the age of 20 cannot be given full licenses and driving for such individuals must be supervised. Implementation of the GDL

from the present minimum driving age of 18 years (Ghana Road Traffic Act; 683 of 2004) to 20 years to provide room for pre-driving years as prevailing in the UK (DVLA UK, 1994) may be advantageous in Ghana. Hazard perception testing (Wetton et al., 2011) is recommended for inclusion in the driver training and licensing procedures of the Ghanaian DVLA based on the evidence of lower hazard monitoring that predicted crash involvement in this study. Hazard perception tests are computer-based tests that train the driver to detect potential hazards on the road (Wetton et al., 2011) and as such can be introduced relatively cheaply.

5. 2. 2. Traffic law enforcement

It was found in this study that risky driving behaviours; violations and errors are more common and more strongly related to crash involvement in Ghana than the UK. This may reflect effective traffic law enforcement and regulation in the UK mitigating the consequences of dangerous driving behavioural tendencies. These controls may be much less effective in Ghana. Presently the traffic law enforcement and training and licencing procedures in Ghana are tainted by corruption that allows untrained, unlicensed and improperly licenced motorist on the roads. A key strategy that may be effective in dealing with the challenge in Ghana is enforcement. Most demonstrable gains made from changing road user behaviour in motorised countries came from traffic safety laws (Zaza et al., 2001). However, traffic laws by themselves are not always sufficient; the key factor in the effectiveness of a traffic law is the perception of the motorists that they run a high risk of being detected and punished for violations (Nagin, 2013). The severity or swiftness of the penalty is a much less restraint than the perception of the likelihood of apprehension (Ross, 1984). It was found in the USA and much of Europe that regulations requiring motorcyclists to use crash helmets typically produced almost a total compliance (close to 100%). This is largely due to riders knowing they can easily be identified if they ride without a crash

helmet (O'neill & Mohan, 2002). But helmet use is much lower in countries where motorcyclists perceive that such laws are not likely to be enforced (O'Neill & Mohan, 2002).

To check the common violations of traffic regulations identified in this study, effective ticketing for penalties (e.g., speeding tickets) that have been helpful in the developed countries could be introduced. Even though the use of speed cameras may not prove effective in Ghana due to challenges with the vehicle registration and postal addressing system, police enforcement may achieve the most effective results. The point system of punishing offending drivers could be introduced along with the fines. This system does not exist in Ghana currently. A driver who violates traffic rules loses a point off his/her license. One may lose all points leading to the withdrawal of the license. The withdrawal of license may however not be effective in stopping people from driving in Ghana unless it is implemented within an improved enforcement framework. An effective system of enforcement may not work if the corruption/bribery in the traffic law enforcement reported in Ghana exists. Regarding speeding, the use of speed limiters and soon to be introduced Intelligent Speed Assistance systems in all vehicles that prevent speeding in some developed countries(https://ec.europa.eu/transport/road_safety/specialist/knowledge/speed/new_technologies_new_opportunities/intelligent_speed_adaptation isa en) may be helpful in Ghana.

Further safety benefits through enforcement could come from regulating working hours, especially for Ghanaian commercial drivers. This could be monitored and enforced through the introduction of tachograph rules in the face of the evidence from our qualitative data that commercial drivers work for between 8 to 10 hours a day some with little or no rest. This would help in enforcing the laws about driving hours in Ghana's road safety laws (Act 295 of 2004). The revenue (‘sales') target setting regime for commercial passenger drivers in Ghana; a system where the driver accounts for a fixed amount of revenue daily could be

revised through collaboration between the Ghana Private Road Transport Union and the transport owners. This is necessary due to the excessive competition for passengers that have been uniquely identified (see Chapter Two) to be a critical crash risk factor.

5. 2. 3 Training and education to change road user behaviour

Education or training programmes for drivers have often not been found to reduce motor vehicle crashes in the developed world, but they still are widely advocated as essential safety programmes (Mayhew, Simpson, Williams, & Ferguson, 1998; Roberts & Kwan, 2001; Vernick et al., 1999). However, education programs may be relevant in the context of the Global South where the underlying behaviours of driver crash risks appear to differ from that of the developed world. It also remains important to consider the timing of training. Thus, training of certain skills such as hazard monitoring at pre-driving and pre-licensing stages may be advantageous in addressing risk factors in the Global South. Wells (2008) provided evidence that hazard perception training was effective in reducing crashes for new drivers in the UK. Targeting education and training at improving maintenance practices in Ghana may be useful.

Drawing on both the qualitative and the quantitative data collected in this study, it was found that the number of Ghanaian drivers (commercial drivers) trained through the apprenticeship model appears higher than those trained in formal driving schools (see Table 4.1, Chapter Four). More frequent risky driving behaviours were attributed to drivers without any formal training (15.3%, see Table 4.1, Chapter Four) in the present sample from Ghana. Presently the evidence of knowledge in defensive driving such as interpretation of road signs among trainee apprentices is limited. However, only weak associations between form of driver training (apprenticeship and formal) and breaking of driving codes in Ghana have been found (Akaateba, Amoh-Gyimah, & Amponsah, 2015). The apprenticeship model

of driver training needs to be redesigned and regulated to provide the necessary driving skills to commercial drivers.

The qualitative data reported in Chapter Two showed that some drivers break speed limits on roads that are in good condition in Ghana that results in higher fatalities. To reduce the crash rates and fatalities on such roads there is the need for reclassification of some highways into urban roads. This allows for the imposition of speed limits on such roads and installation of traffic calming devices; zebra crossing and pedestrian crossing traffic controls. This must be accompanied by proper signage, education and enforcement.

From the path modelling in Chapter Four, the salient distal factors in Ghana; anxiety, fatalistic beliefs and distraction would be good targets for intervention through training and education. If mean levels could be changed to that of UK then, according to the model, that would lead to substantial road safety improvement in Ghana. Anxiety is difficult for a purely driving focussed intervention to change. However, fatalistic belief is a prime target for educational intervention through public information posters and the electronic media could help to achieve this. Distraction could also be intervened with, using a combination of education and enforcement.

5.3 Future studies

The three studies reported in this thesis point to some important issues to be considered in future driving behaviour research. Further, quantitative studies to unearth other behaviours that the DBQ should focus on to fully capture errors and violations in the Ghanaian context are required. A longitudinal study to test the mediation hypotheses more clearly is recommended. Additionally, intervention studies to deal with the crash risk factors identified in the present study are recommended. Such studies may be targeted at salient

factors within the distal context; for example, anxiety and fatalistic beliefs that largely influenced the country effects on crash risks and crash involvement. Subtle differences were found in the applicability of the DBQ in European countries (Lajunen et al., 2004). It remains important to explore whether the DBQ factor structure found for Ghana in the present study applies similarly across the Global South. Due to the limitations of self-reported nature of the present study, as discussed in Section 4.4.10, it would be useful to replicate these results using a different method of measuring crash involvement (e.g., state recorded crashes). There were some differences in the effects of some of the factors measured in the present study (e.g., beliefs and risky driving) between Ghana and the UK. It will be advantageous for future studies to focus on the adaptation of some of the other measures that have worked for the developed world; for example hazard perception testing discussed above (see Section 5.2.1), prior to introducing them to the Global South contexts. Designing and validating a hazard perception test in Ghana would therefore be a good future project.

5.4 Summary and Conclusion

This thesis aimed to understand the relationship between behavioural factors and driver crash risks and the extent to which driver crash prediction models from the Western world (e.g., the contextual mediated model [Sumer, 2003]) generalises to the context of Ghana. Collectively, the studies reported in this thesis demonstrate that there are common driver crash risk factors for Ghana and the developed world, though the Ghanaian context moderates some while others are unique to Ghana (study 1). Taken together with the other results reported here it shows that the DBQ provides an effective measure of driving behaviours that increase the risk of crash in the Ghanaian context and that the revised contextual mediated model can be applied to driving in Ghana and possibly other countries of the Global South that share similar traffic cultures. This model may be used for road

safety research, including as an outcome measure in studies that try to improve road safety behaviours. Notwithstanding, care needs to be taken when applying the model because the microstructure of the DBQ differs from the western world. The findings broaden our views on the predictors of road crashes. The findings indicate that driver crash involvement in Ghana just as in the Western world (e.g., The UK) can be explained by a number of distal factors (e.g., fatigue and distracted driving) that are mediated by a set of proximal factors (violations, errors and hazard perception). A novel contribution of this thesis has been the identification of the role of fatalistic belief and corruption in the Global South, predictors that are less often mentioned in Western literature. These factors can be targets for the formulation and design of potential intervention policies and strategies to reduce road crashes in Ghana and other countries of the Global South.

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Appendices

Appendix A: Interview Guide (Study I: Qualitative)

Pres-Screening Question(s)

1. Are you currently driving or not (not driving/without a car)? A. Driving B. Not driving
2. If not driving for how long since you last drove? A. Less than 6months B. 6+ months.

Demographic Information Questions

1. Do you have/hold a valid driving license? A. Yes…… B. No……
2. Will you kindly tell me your age ……
3. For how long have you been in commercial driving? Have you any other form of driving experience?
4. Which type of vehicle do you usually drive?
5. Travel distance A. Long……. 500km+ B. Short ……. < 500km
6. How often do you share the driving with another driver?

Now I am going to give you a brief overview of the current accident situation after which we will discuss some few issues.

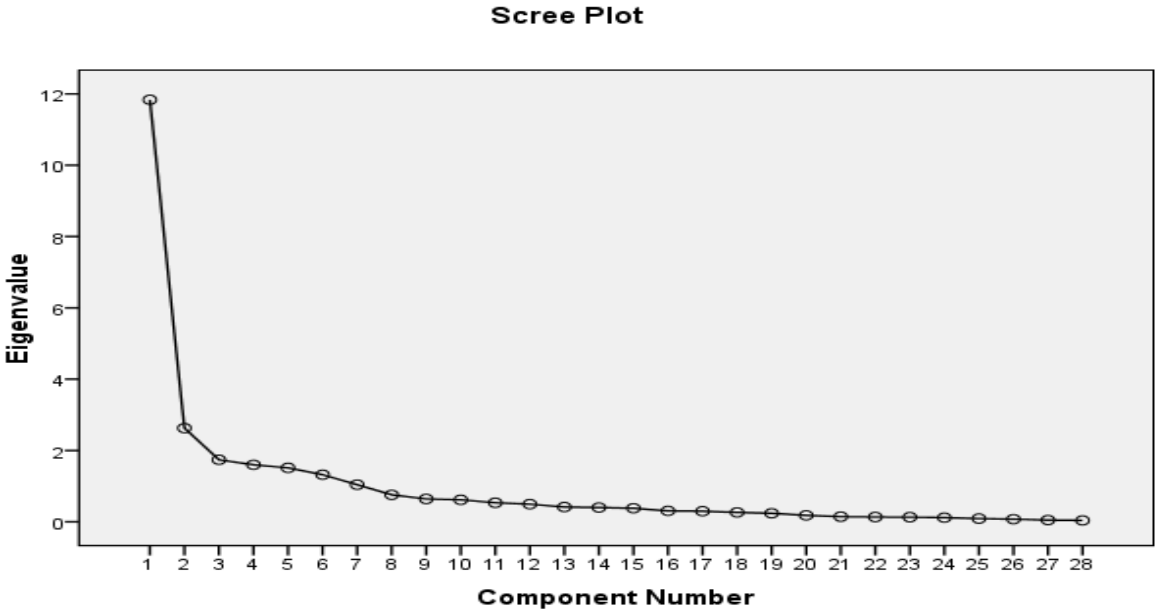
'..Globally over 1.2 million people die each year on the world's roads with millions more sustaining serious injuries (WHO, 2015). Road crashes in Ghana for the year 2015 stood at 13,133 cases of accidents involving 16,598 vehicles. This resulted in 1,634 deaths - with 9,186 sustaining severe injuries (National Road Safety Commission, 2016). These numbers are predicted to increase in coming years... '

Research Interview Questions

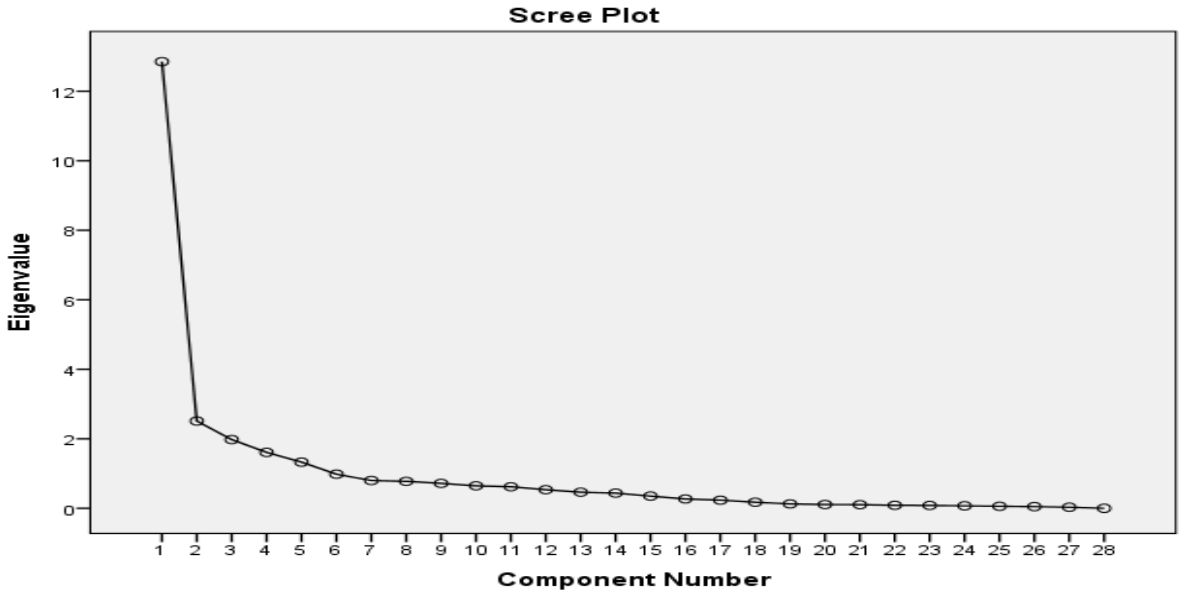
1. What is your typical day as a driver like?
2. Do you find anything stressful about your typical day? What are the pressures?
3. Briefly tell me about your experiences with crashes/accidents and the factors you might identify as being responsible?
4. Will you tell me a little bit about your training?
5. What has changed about driver training and driving since your training?
6. What can you say about the driving environment (in terms of roads, safety etc)?
7. Will you recommend that anybody at all at any time once he/she is of age can go into commercial driving? Why and why not?
8. Is there anything else you want to share concerning the causes of crashes on our roads?
9. What is the greatest priority in increasing road safety in Ghana?

Thank you very much for your time

Appendix B1: *Scree plot from the Exploratory Factor Analysis of the Driver Behaviour Questionnaire in Ghana based on Study II sample (N=453)*



Appendix B2: *Scree plot from the Exploratory Factor Analysis of the Driver Behaviour Questionnaire in Ghana based on the main study data (N=478)*



Appendix B3: Exploratory Factor Loadings of the Driver Behaviour Questionnaire (DBQ) items based on the main study sample in Ghana (N = 478)

	Item	EFA (GH)	
		Viol	Error/lapses
AV1	Become angered by another driver and give chase with the intention of giving him/her a piece of your mind.	.75	
OV1	Race away from traffic lights with the intention of beating the driver next to you	.81	
E1	Attempt to overtake someone that you had not noticed to be signalling a left turn	.77	
OV2	Disregard the speed limit on a motorway	.89	
AV2	Become angered by a certain type of a driver and indicate your hostility by whatever means you can	.79	
OV3	Disregard the speed limit on a residential road	.75	
AV3	Sound your horn to indicate your annoyance to another road user	.75	
OV4	Cross a junction knowing that the traffic lights have already turned against you	.70	
L1	Attempt to drive away from the traffic lights in third gear	.68	
OV5	Drive so close to the car in front that it would be difficult to stop in an emergency	.71	
OV6	Pull out of a junction so far that the driver with right of way has to stop and let you out	.70	
OV7	Stay in a motorway lane that you know will be closed ahead until the last minute before forcing your way into the other lane	.58	
E2	Underestimate the speed of an oncoming vehicle when overtaking	.68	
E3	Brake too quickly on a slippery road or steer the wrong way in a skid	.60	
E4	Miss "Give Way" signs and narrowly avoid colliding with traffic having right of way	.59	
E5	Fail to check your rear-view mirror before pulling out, changing lanes, etc	.66	
L2	Realise that you have no clear recollection of the road along which you have just been travelling		.61
L3	Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers		.66
E6	Fail to notice that pedestrians are crossing when turning into a side street from the main road		.87
L4	Misread the signs and exit from a roundabout on the wrong road		.79
L5	Forget where you left your car in a car park		.58
OV8	Overtake a slow driver on the inside		.87
E7	On turning left nearly hit a cyclist who has come up on your inside		.77
L6	Get into the wrong lane approaching a roundabout or a junction		.63
E8	Queuing to turn right onto a main road, you pay such close attention to the mainstream of traffic that you nearly hit the car in front		
L7	Hit something when reversing that you had not previously seen		
L8	Intending to drive to destination A, you 'wake up' to find yourself on the road to destination 'B'.		
OV9	Drink and drive		

Only loadings > .50 were shown
AV- aggressive violation, OV – ordinary violation, E – error and L – lapse

Appendix C: Correlation between socio-demographic factors and observed scales

Source	Hazard		Viol	Ord.Viol	Agg. Viol	Errors		Lapses	Crash Inv	
	GH	UK	GH	UK	UK	GH	UK	UK	GH	UK
Sex	-.09	.00	.05	.13*	.12*	-.00	-.07	-.06	.02	-.02
Age	.02	.06	-.04	-.18**	-.06	.01	.14**	.22**	.01	.01
Experience	.02	.21**	.16**	.07	.12*	-.15**	-.06	-.03	-.06	-.17**
Mileage	-.13**	-.08	.52**	.10*	.14**	.51**	.07	.05	.38**	.08

N (GH = 478, UK = 404), *= p < .05, **= p < .01, sex (female =0, Male = 1), weekly mileage (100 and below =0, Above100 = 1), crash involvement (no crash = 0, at least once = 1

Appendix D, Table 1: Correlations among continuous scale scores

Variable	Anx		Imp		Extrv		Agreab		Consc.		Neuro		Open		Belief		Risk	
	GH	**UK**	**GH**	**UK**	**GH**	**UK**	**GH**	**UK**	**GH**	**UK**	**GH**	**UK**	**GH**	**UK**	**GH**	**UK**	**GH**	**UK**
Anxiety	1	1																
Impulsivity	-.07	.68***	1	1														
Extraversion	.12*	.13**	.07	.16**	1	1												
Agreeableness	.10*	.01	.01	-.01	.05	-.28**	1	1										
Conscienti.	.06	-.01	-.16**	-.04	-.06	-.47***	.02	.74**	1	1								
Neuroticism	.04	.13**	.12**	.15**	.24**	.38***	-.03	-.08	-.06	.15**	1	1						
Openness	-.09*	-.03	-.32***	-.08	-05.*	-.47***	.01	.71**	-.09	-.90***	.13**	-.163	1	1				
Beliefs	.04	-.14**	.16**	-.16**	.19**	-.02	-.01	.02	-.10**	.-.03	.65***	.07	-.11*	-.09	1	1		
Risk perception	.00	-.12*	-.09	-.10*	.03	-.26**	.03	.12*	.02	.27**	-.60***	-.05	.13**	.28**	-.64***	.03**	1	1
Aggression	.05	.17**	.25**	.11*	.26**	.36***	.05	-.27**	-.03	.37***	.46***	.04	-.07	-.36***	.46***	-.10**	-.43***	-.09**
Dislike	.01	.06	.17**	.08	.23**	.46***	-.01	-.34***	-.11*	-.45***	.47***	.19**	.05	-.47***	.45***	.10**	-.37***	-.14**
Hazard Monitoring	-.04	-.05	-.01	-.01	.04	-.37***	.00	.28**	-.09	-.40***	-.21**	-.04	-.09	.40***	-.16**	-.01**	.22**	.27**
Fatigue	.03	.06	.12**	.04	.29**	.35***	-.04	-.28**	-.06	-.35***	.37***	.13*	.05	-.37***	.40***	.10*	-.29	-.09
Thrill	.03	.07	.16**	.04	.20**	.34**	-.08	-.34***	-.06	-.39***	.45***	-.01	-.05	-.43***	.45***	.04	-.39***	-.28
Distraction	.07	.07	.16**	.15**	.24**	.07	.08	-.03	-.07	-.07	.51***	.01	-.16**	-.09	.49***	.13**	-.44***	-.17**
Maintenance	.05	.01	-.12*	-.02	-.17**	.02	.14**	-.04	.16**	-.00	-.22**	.08	.02	.04	-.09	-.15**	.02	.02
Violations	.45***		.13**		.22**		-.02		-.10*		.36***		-.02		.36***		-.19**	
Ord. violations		.20**		.30**		.26**		-.17**		-.18**		.11*		-.18**		-.07		-.22**
Agg. Violations		.26**		.42**		.18**		-.09		-.09		.07		-.09		-.04		-.22**
Errors	.27**	.35***	.18**	.53**	.27**	.22**	-.01	-.10*	-.08	-.06	.51***	.05	-.03	-.06	.54***	-.08	-.34***	-.17**
Lapses		.24**		.34**		.27**		-.20**		-.25**		.09		-.22**		-.05		-.19**
Crash invol.	-.03	.00	.10**	.16**	.20**	.23**	-.02	-.22**	-.05	-.12*	.33***	.18**	-.02	-.13*	.34***	-.06	-.24**	-.01

N (GH = 478, UK = 404),
**p<.05, **p<.01, *** p<.001*
Empty cells in table due to differences in factor structure of the DBQ between Ghana and UK

Appendix D, Table 2: Correlations among continuous scale scores (continued)

Source	Aggr.		Dislike		Hazard		Fatigue		Thrill		Distraction		Maint		Viol	Ord. viol.	Agg. viol	Errors		Lapses
	GH	UK	GH	UK	GH	UK	GH	UK	GH	UK	GH	UK	GH	UK	GH	UK	UK	GH	UK	UK
Aggression	1	1																		
Dislike	.63***	.54***	1	1																
Hazard Monitoring	-.12**	-.50***	-.22**	-.49***	1	1														
Fatigue	.60***	.57***	.61***	.57***	-.10*	-.50***	1	1												
Thrill	.56***	.64***	.64***	.46***	-.24**	-.69***	.65***	.59***	1	1										
Distraction	.63***	.19**	.64***	.11**	-.25**	-.03	.59***	.18**	.68***	.17**	1	1								
Maintenance	-.17**	.01	-.19**	-.16**	-.09*	.01*	-.22**	-.08	-.18**	.03	-.24**	-.09*	1	1						
Violations	.49***		.48***		-.17*		.53***		.46***		.53***		.37***							
Ord. viol		.29**		.20**		-.13**		.12**		.30***		.32***		.00		1				
Agg. viol		.20**		.13**		-.14**		.09		.19**		.22**		.04		.75***	1			
Errors	.42***	.09	.47***	.11**	-.11*	-.08	.50***	.19	.45***	.10**	.49***	.14**	.27**	-.07	.69***	.54***	.70***	1	1	
Lapses		.26**		.32***		-.26**		.23**		.26**		.20**		-.07		.65***	.65***		.68***	1
Crash invol.	.35***	-.00	.39***	.17**	-.13**	-.11*	.39***	.16*	.38***	.07	.36***	.07	.15**	-.06	.32**	.12**	.20**	.28**	.19**	.15**

N (GH = 478, UK = 404),
**p<.05, **p<.01, *** p<.001*
Empty cells in table due to differences in factor structure of the DBQ between Ghana and UK

Appendix E: Driver Behaviour Questionnaire

The University Of Sheffield.

Driver Behaviour Questionnaire

This questionnaire asks you about your driving, personality and beliefs. There are no right or wrong answers and your answers will be treated as strictly confidential. So please try to respond to these questions as accurately and truthfully as possible.

Demographic Information:

1 Have you driven in most weeks over the last 6 months? **Yes** ☐ **No** ☐

2 What is your age? .....years

3 Sex Male ☐ Female ☐

4 Level of Education: Primary/JHS/Middle School ☐ Secondary ☐
Diploma ☐ **1st** Degree and above ☐

5 For how long have you been driving? .....years

6 How many kilometres (Km) on average do you drive over a week? .....km

7 Please state your usual journey; I usually drive from.....to.....

8 What type of vehicle do you usually drive? Private car ☐ Taxi ☐
Light weight buses (e.g. 23 seater) ☐ Big bus/coach ☐
Mini bus (e.g., Urvan/sprinter) ☐ Goods truck ☐

9 How often do you employ the assistance of a 'spare driver' (another driver) to relieve you?
Not at all ☐ Occasionally ☐ Often ☐ Very often ☐

10 How many hours of continuous (non-stop driving) do you usually do in your daily driving?.....hrs

11 How were you trained to be a driver? Apprenticeship ☐ Driving School ☐ No training ☐
Friends/family ☐ Others (State).....

12 Do you have/hold a valid driving license? No ☐ Yes, Provisional ☐ Yes, Full ☐

13 If yes to the question above, have you passed a driving test prior to being issued a licence?
No ☐ Yes ☐

14 What class of license do you hold? **A** ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐ **F** ☐

15 Have you been involved in a crash involving damage to property and/or injury to yourself or someone else since you started driving? No ☐ Yes, once ☐ Twice ☐
Three times ☐ Four times ☐ Five times or more ☐

16 Have you had any driving related convictions in the last 12 months?
No ☐ Yes, once ☐ Twice ☐
Three times ☐ Four times ☐ Five times or more ☐

17 Do you sometimes have to pay/bribe police/traffic law enforcement officers in the course of your daily work as a driver? **Never** ☐ **Sometimes** ☐
Often ☐ **Almost always** ☐

18 In comparison to the N1 highway and Tema motorway as **GOOD** roads, how will you describe the condition of the road on which you do the largest proportion of your driving?
Very good ☐ Good ☐ Neither good nor bad ☐
Bad ☐ Poor ☐

		Never	Hardly ever	Occasionally	Quiet often	Frequently	Nearly all the time
1	Hit something when reversing that you had not previously seen	☐	☐	☐	☐	☐	☐
2	Intending to drive to destination A, you "wake up" to find yourself on the road to destination B	☐	☐	☐	☐	☐	☐
3	Drink and drive	☐	☐	☐	☐	☐	☐
4	Get into the wrong lane approaching a roundabout or a junction	☐	☐	☐	☐	☐	☐
5	Queuing to 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	☐	☐	☐	☐	☐	☐
6	Fail to notice that pedestrians are crossing when turning into a side street from a main road	☐	☐	☐	☐	☐	☐
7	Sound your horn to indicate your annoyance to another road user	☐	☐	☐	☐	☐	☐
8	Fail to check your rear-view mirror before pulling out, changing lanes, etc	☐	☐	☐	☐	☐	☐
9	Brake too quickly on a slippery road or steer the wrong way in a skid	☐	☐	☐	☐	☐	☐
10	Pull out of a junction so far that the driver with right of way has to stop and let you out	☐	☐	☐	☐	☐	☐
11	Disregard the speed limit on a residential road	☐	☐	☐	☐	☐	☐
12	Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers	☐	☐	☐	☐	☐	☐
13	On turning right nearly hit a cyclist who has come up on your inside	☐	☐	☐	☐	☐	☐
14	Miss "Give Way" signs and narrowly avoid colliding with traffic having right of way	☐	☐	☐	☐	☐	☐
15	Attempt to drive away from the traffic lights in third gear	☐	☐	☐	☐	☐	☐
16	Attempt to overtake someone that you had not noticed to be signaling a left turn	☐	☐	☐	☐	☐	☐
17	Become angered by another driver and give chase with the intention of giving him/her a piece of your mind.	☐	☐	☐	☐	☐	☐
18	Stay in a motorway lane that you know will be closed ahead until the last minute before forcing your way into the other lane	☐	☐	☐	☐	☐	☐

Your driving behaviour continued…

		Never	Hardly ever	Occasionally	Quiet often	Frequently	Nearly all the time
19	Forget where you left your car in a car park	☐	☐	☐	☐	☐	☐
20	Overtake a slow driver on the inside	☐	☐	☐	☐	☐	☐
21	Race away from traffic lights with the intention of beating the driver next to you	☐	☐	☐	☐	☐	☐
22	Misread the signs and exit from a roundabout on the wrong road	☐	☐	☐	☐	☐	☐
23	Drive so close to the car in front that it would be difficult to stop in an emergency	☐	☐	☐	☐	☐	☐
24	Cross a junction knowing that the traffic lights have already turned against you	☐	☐	☐	☐	☐	☐
25	Become angered by a certain type of a driver and indicate your hostility by whatever means you can	☐	☐	☐	☐	☐	☐
26	Realise that you have no clear recollection of the road along which you have just been travelling	☐	☐	☐	☐	☐	☐
27	Underestimate the speed of an oncoming vehicle when	☐	☐	☐	☐	☐	☐

	overtaking										
28	Disregard the speed limit on a motorway	☐	☐		☐	☐		☐	☐		

Your Driving Behaviour

Thinking about your driving over the past year, please put a tick in the box that shows how far you agree with the statements that comes closest to reflecting your behaviour when driving. Please provide only one answer to each statement

Your everyday feelings

Please put a tick in the box against the following statements that come closest to reflecting *"how you generally feel"*.

		Almost Never	sometimes	Often	Almost Always
1	I tire quickly	☐	☐	☐	☐
2	I worry too much over something that really doesn't matter	☐	☐	☐	☐
3	Some unimportant thought runs through my mind and bothers me	☐	☐	☐	☐
4	I am a steady person	☐	☐	☐	☐
5	I feel confident	☐	☐	☐	☐

Your everyday behaviour

Please put a tick in the box that show how far you agree with the statements that comes closest to reflecting your level of impulsivity.

		Rarely/ Never	sometimes	Often	Almost Always
1	I act on impulse	☐	☐	☐	☐
2	I act on the spur of the moment	☐	☐	☐	☐
3	I do things without thinking	☐	☐	☐	☐
4	I say things without thinking	☐	☐	☐	☐
5	I buy things on impulse	☐	☐	☐	☐
6	I plan for job security	☐	☐	☐	☐
7	I plan for the future	☐	☐	☐	☐
8	I save regularly	☐	☐	☐	☐
9	I plan tasks carefully	☐	☐	☐	☐
10	I am a careful thinker	☐	☐	☐	☐
11	I am restless at lectures or talks	☐	☐	☐	☐
12	I squirm at plays or lectures	☐	☐	☐	☐
13	I concentrate easily	☐	☐	☐	☐
14	I don't pay attention	☐	☐	☐	☐
15	Easily bored solving thought problems	☐	☐	☐	☐

Your Personality

Please put a tick in the box that shows how far you agree with the statements about your personality.

	I see myself as someone who …	Strongly disagree	Disagree a little	Neither disagree nor agree	Agree a little	Strongly agree
1	is reserved	☐	☐	☐	☐	☐
2	is generally trusting	☐	☐	☐	☐	☐
3	tends to be lazy	☐	☐	☐	☐	☐
4	is relaxed, handles stress well	☐	☐	☐	☐	☐
5	has few artistic interests	☐	☐	☐	☐	☐
6	is outgoing, sociable	☐	☐	☐	☐	☐
7	tends to find fault with others	☐	☐	☐	☐	☐
8	does a thorough job	☐	☐	☐	☐	☐
9	gets nervous easily	☐	☐	☐	☐	☐
10	has an active imagination	☐	☐	☐	☐	☐

Your beliefs about road crashes

Please put a tick in the box that shows how far you agree with the statements that comes closest to reflecting your level of belief in fate about road crashes.

		Strongly disagree	Disagree	Agree	Strongly agree
1	Accidents are due to fate, nothing can be done about it	☐	☐	☐	☐
2	Certain sections of road are haunted by genii (evil spirits) who provoke accidents	☐	☐	☐	☐
3	Road accidents are often unexplainable	☐	☐	☐	☐
4	When you have an accident it's because someone (in your entourage) wants to hurt you	☐	☐	☐	☐
5	To see a hearse while driving is a bad omen	☐	☐	☐	☐
6	When you indulge in forbidden customs, you expose yourself to an accident	☐	☐	☐	☐
7	If a black cat crosses the road in front of your car, you should redouble your attention	☐	☐	☐	☐
8	There exist mascots and amulets which constitute an efficient protection against accidents	☐	☐	☐	☐
9	It's better to consult a clairvoyant before starting a long voyage: you never know	☐	☐	☐	☐

Your thoughts on crash risk

1. Indicate your probability of being involved in a road crash in the future as a driver on a scale of 1: not probable at all to 7: very probable

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Not probable at all								**Very probable**

2. Indicate how worried and concerned you are regarding being hurt in a traffic accident along a scale of 1: not worried at all to 7: very worried.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Not worried at all								**Very worried**

Your feelings about driving

Please put a tick in the box that shows how far you agree with the statements that comes closest to reflecting your level of stress in course of driving.

		Not at all	slightly	somewhat	very	Very much
1	I really dislike other drivers who cause me problems	☐	☐	☐	☐	☐
2	It annoys me to drive behind a slow moving vehicle	☐	☐	☐	☐	☐
3	I feel tense or nervous when overtaking another vehicle	☐	☐	☐	☐	☐
4	I am disturbed by thoughts of an accident or the car breaking down	☐	☐	☐	☐	☐
5	I usually make an effort to look for potential hazards when driving	☐	☐	☐	☐	☐
6	I make an effort to see what's happening on the road a long way in front of me	☐	☐	☐	☐	☐
7	My reactions to other traffic become increasingly slow when I have to drive for several hours	☐	☐	☐	☐	☐
8	I become sleepy when I have to drive for several hours	☐	☐	☐	☐	☐
9	I get a real thrill out of driving fast	☐	☐	☐	☐	☐

10	I like to raise my adrenaline levels while driving	☐	☐	☐	☐	☐

Your activities while driving

Indicate how frequently you engage in the following activities in the course of driving.

		Never	Rarely	Sometimes	Often	Very often
	When driving, you...					
1	have phone conversations	☐	☐	☐	☐	☐
2	manually interact with a phone (e.g., sending text messages)	☐	☐	☐	☐	☐
3	adjust the settings of in-vehicle technology (e.g., radio channel or GPS)	☐	☐	☐	☐	☐
4	read roadside advertisements	☐	☐	☐	☐	☐
5	visually dwell on roadside accident scenes if there are any	☐	☐	☐	☐	☐
6	chat with passengers if there are any	☐	☐	☐	☐	☐

Your approach to vehicle maintenance

As a driver, how likely you are top perform the following activities in the course of your daily driving.

		Very unlikely	unlikely	Neutral	likely	Very likely
1	Check the water in the radiator	☐	☐	☐	☐	☐
2	Check the pressure in the tyre	☐	☐	☐	☐	☐

Many thanks for your time in completing the questionnaire!

UNIVERSITY OF GHANA
ETHICS COMMITTEE FOR THE HUMANITIES (ECH)

P. O. Box LG 74, Legon, Accra, Ghana

My Ref. No.....

5th May, 2016

Mr. John K. Dotse
University of Sheffield
Department of Psychology
Western Bank
S10 2TP

Dear Mr. Dotse,

ECH 109/15-16: EXPLORATORY STUDY OF FACTORS INFLUENCING DRIVING BEHAVIOUR AND DRIVER CRASH RISKS IN GHANA - A CASE STUDY OF MAJOR BUS TERMINALS IN ACCRA METROPOLIS

This is to advise you that the above reference study has been presented to the Ethics Committee for the Humanities for a full board review and the following actions taken subject to the conditions and explanation provided below:

Expiry Date:	29/03/17
On Agenda for:	Initial Submission
Date of Submission:	21/02/16
ECH Action:	Approved
Reporting:	Bi-Annually

UG/ISSER/ECH
VALID UNTIL
29 MAR 2017
APPROVED DOCUMENT

Please accept my congratulations.

Yours Sincerely,

Rev. Prof. J. O. Y. Mante
ECH Chair

Tel: +233-303933866

Email: ech@ug.edu.gh | ech@isser.edu.gh

Approved: 18/02/2016

John Dotse

Registration number: 150123912

Psychology

Programme: PhD Psychology

Dear John

PROJECT TITLE: Exploratory Study of Factors Influencing Driving Behaviour and Driver Crash Risks in Ghana

APPLICATION: Reference Number 007634

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 18/02/2016 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 007634 (dated 05/02/2016).
- Participant information sheet 1015197 version 1 (05/02/2016).

Participant consent form 1015198 version 1 (05/02/2016).

If during the course of the project you need to **deviate significantly from the above-approved documentation** please inform me since written approval will be required.

Yours sincerely

Thomas Webb

Ethics Administrator

Psychology

Approved: 03/02/2017

John Dotse

Registration number: 150123912

Psychology

Programme: PhD Psychology

Dear John

PROJECT TITLE: Validation of the Driver Behaviour Questionnaire (DBQ) in Ghana

APPLICATION: Reference Number 012431

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 03/02/2017 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 012431 (dated 20/01/2017).
- Participant information sheet 1026337 version 2 (19/01/2017).

Participant consent form 1026338 version 2 (19/01/2017).

The following optional amendments were suggested:

Reviewers felt that it would be helpful to have more information about the aims and objectives of the research. More importantly reviewers were unclear on whether the data is confidential or anonymised. A check of the materials suggests that the consent forms will be kept confidentially and the questionnaires will be anonymous, but please make this distinction clear in future applications.

If during the course of the project you need to **deviate significantly from the above-approved documentation** please inform me since written approval will be required.

Yours sincerely

Thomas Webb

Ethics Administrator

Psychology

Downloaded: 11/02/2018

Approved: 11/02/2018

John Dotse

Registration number: 150123912

Psychology

Programme: PhD Psychology

Dear John

PROJECT TITLE: Behavioural Predictors of Driver Crash Risks in Ghana.

APPLICATION: Reference Number 017665

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 11/02/2018 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 017665 (dated 08/02/2018).
- Participant information sheet 1039190 version 3 (08/02/2018).

Participant consent form 1039191 version 2 (08/02/2018).

If during the course of the project you need to **deviate significantly from the above-approved documentation** please inform me since written approval will be required.

Yours sincerely

Thomas Webb

Ethics Administrator

Psychology