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The role of executive function, personality and attitudes to risks in explaining self-reported driving behaviour in adolescent and adult male drivers

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ABSTRACT

Young drivers show high levels of risky driving and are over-represented in motor vehicle crash statistics world-wide. As well as personality and attitudinal factors, high rates of risk taking during adolescence may be due to poorly developed executive functions, a result of the slow maturation of the pre-frontal cortex of the brain. This study was undertaken to investigate the roles of executive function, personality, attitudes to risk in relation to self-reported driving behaviour. Adolescent ($n = 46$, age 16–18 years) and adult ($n = 32$, 25 years and over) male drivers completed a battery of neuropsychological tests to assess general cognitive ability and executive function, and questionnaires to assess driving history, personality, attitudes to physical and psychological risk as well as questionnaires of self-reported driving behaviour (Driver risk taking and Driver Attitude Questionnaire, DAQ). The adolescent drivers showed poorer executive function, higher levels of impulsivity and risk-taking, lower levels of agreeableness and conscientiousness compared to adult drivers. Regression analyses revealed that attitudes to risk, agreeableness and working memory made unique significant contributions in explaining self-reported driving behaviour. Interestingly though, better working memory was associated with higher levels of self-reported risky driving and more accepting attitudes to risky driving. Together the findings suggest that some aspects of executive function, personality, and attitudes to risk may help to explain self-reported driving behaviour. Whether these findings are relevant to female drivers and apply to on-road driving behaviour should be the focus of future studies.

1. Introduction

Vehicle related crashes are one of the most common causes of death and disability, with young drivers being over-represented in motor vehicle crash statistics in the majority of OECD countries (International Road Traffic Database, 2010). Within the young driver group, crash rates are related to age and gender with the youngest (16 years) male drivers having the highest risk of involvement in fatal and non-fatal crashes (per 100 million miles travelled), with rates dropping steeply between 20 and 25 years of age (Ferguson, Teoh, & McCartt, 2007; MacDonald, 1994; Mayhew, Simpson, & Pak, 2003). Studies suggest that the high crash rate in young drivers is due to a combination of inexperience (Mayhew, 2007),

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as demonstrated by the decreased rates of culpable crashes as length of licensure increases (Cooper, Pinili, & Chen, 1995), and age, as shown by a general decrease in the total number of crashes with increasing age (Cooper et al., 1995; Lewis-Evans, 2010). These age-related decreases in crash rate may in part be explained by more general changes in behaviour, in particular attitudes and propensities for risk-taking. In this regard, it has been suggested that risk-taking plays a significant role in young driver crashes; a review of 1296 crash reports and subsequent police interviews in the United Kingdom (UK) found that risk-taking, rather than poor driving skill, best explained the higher crash rate in young drivers (Clarke, Ward, & Truman, 2005). Another study of over 20,000 novice drivers in Australia, revealed that high scores on self-reported risky driving questions were associated with a 50% increase in crash risk, when all other confounding factors (age, gender, country of birth, socioeconomic status, area of residence, month son learner licence, number of supervised driving hours (professional and private) number of attempts at driving test, self-rated driving ability, weekly driving exposure, months since provisional licence and crash history) were controlled for Ivers et al. (2009).

The reason underlying the high level of risk taking in adolescents has been the focus of numerous studies. Motives underlying risk-taking include: personality factors such as thrill-seeking, social deviance, impulsiveness and aggression (Jessor, 1987; Jonah, 1997; Oltedal & Rundmo, 2006; Ulleberg, 2001; West, Elander, & French, 1993), peer influence (Gardner & Steinberg, 2005; Scott-Parker, Watson, & King, 2009), and the perceived benefit of the high-risk behaviour outweighing the costs (Job, 1995; Parker, Manstead, Stradling, & Reason, 1992). In addition, pubertal hormones have often been cited as the key factor in increased risk-taking in adolescence, but there is little evidence for this (Dahl, 2004), instead there is accumulating evidence that the immature prefrontal cortex may play a significant role. This area of the brain has been described as the 'CEO' of the brain as it co-ordinates inputs from other brain areas to direct behaviour and actions to achieve a specific goal. It plays a key role in a complex set of behaviours collectively known as 'executive functions' which cover three main domains: initiation, maintenance and cessation of action; abstract and conceptual thinking; and goal directed behaviour (Luria, 1973). Damage to the prefrontal cortex can result in a range of symptoms including; poor judgement, organisation, planning and decision making as well as behavioural disinhibition, perseveration, and poor attention and working memory (Lezak, Howieson, Bigler, & Tranel, 2012). Of particular importance in terms of adolescent risk taking is the fact that self-regulatory abilities mediated by the lateral prefrontal cortex are still developing (Dahl, 2004, 2008; Eshel, Nelson, Blair, Pine, & Ernst, 2007; Lenroot & Giedd, 2006; Luria, 1973). Steinberg (2007, 2010) has taken this a step further and suggests that the interaction between two neurobiological systems that develop at different rates may explain adolescent risk taking (the dual systems model). The socio-emotional system (the limbic and paralimbic areas of the brain) undergoes rapid development in puberty leading to increased reward and sensation seeking. At the same time, the executive control system (lateral prefrontal brain regions) has yet to develop fully leading to poor impulse control and self-regulatory abilities. This mismatch may lead to adolescents being vulnerable to increased risk taking and sensation seeking until the lateral prefrontal cortex is fully developed in the early to mid-twenties (Dahl, 2008; Steinberg, 2010).

The findings from several studies support the role of executive functions in adolescent risk-taking. Recently, Pharo, Sim, Graham, Gross, and Hayne (2011) examined the relationships between risky personality traits, executive function and self-reports of real word risk taking in a sample of young adolescents (13–17 years $n = 136$) and young adults (18–22 years, $n = 57$). Participants completed a battery of neuropsychological tests to assess executive function and a series of questionnaires about their involvement in various risky behaviours including smoking, drug use, sexual behaviour, risky driving, anti-social behaviour and alcohol use. Males obtained significantly higher scores compared to females on each of the risky behaviour domains (apart from sexual behaviour). High scores on the risky personality measure correlated positively with the composite measures of real-life risk taking, and executive function correlated negatively with risk-taking, thus providing support for both aspects of the dual systems model, that is increased sensitivity of the reward circuitry for sensation seeking accompanied by poorly developed self-regulatory abilities (executive functions) in adolescents and young adults (Steinberg et al., 2008). However, as analyses were conducted on the composite measure of real-life risk taking, rather than the individual components, the study provides only limited insights into the roles of risky personality traits and executive function in driving. Other studies have, however, examined driving behaviour more directly.

Mäntylä, Karlsson, and Marklund (2009) examined the relationship between executive function and driving performance in a simulated lane change task in 50 adolescents aged 15–19 years. In these drivers, poorer working memory related to significantly more errors in the simulated driving task, suggesting that executive functions may play an important role in safe driving. The authors also highlighted the fact that young drivers may have an increased crash risk soon after licensure because they have less efficient executive function and as yet, their driving skills are still not fully proceduralised (Mäntylä et al., 2009). Worryingly, licensure also coincides with young drivers rating themselves as less likely to be involved in an crash than other drivers of a similar age, even though they accept young drivers are over-represented in the crash statistics (Delhomme, 1991; Finn & Bragg, 1986; Matthews & Moran, 1986) and young male drivers in particular are prone to overestimate their own driving ability (Job, 1995; McKenna, Stanier, & Lewis, 1991).

In a somewhat older cohort of licensed drivers, ($n = 44$, mean age = 20.50 years) higher risk taking was associated with faster speeds on a virtual reality driving task. Interestingly, better performance on a task of attention, visual scanning and processing speed also predicted higher speeds when driving around curves (Graefe & Schultheis, 2013). These findings suggest that better executive function may actually increase driver risk taking, possibly because they feel capable of dealing with unplanned or unforeseen consequences of their actions (Patrick, Blair, & Maggs, 2008), an explanation that has some support from a study examining intention to speed based on the Theory of Planned Behavior (TPB) (Ajzen, 1991). Cestac, Paran, and Delhomme (2011) examined the roles of traditional TPB variables (i.e., intentions, attitudes, subjective norms