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The contribution of inhibitory deficits to dangerous driving among young people

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ABSTRACT

A recent theory of adolescent risk taking that may be applicable to young drivers proposed that young people engage in more risks because they are more impulsive. While past research has found that problematic drivers do tend to score higher on measures of impulsivity, most of this research has relied on self-reported behaviours and attitudes. The present study investigates the role of impulsivity using computer-based measures of inhibitory functioning. Young drivers who had been caught speeding by the police were compared with non-offenders on two inhibitory measures: the Stop-signal task and the Go/no-go task. While the two groups did not differ in their performance on the Stop-signal task, there were significant differences between the groups on the Go/no-go task with the offender group displaying lower inhibitory skills. The results of the Go/no-go task were not entirely unambiguous as offenders were also found to have responded to go trials with a faster reaction-time. The implications of these results both for the impulsivity theory of adolescent risk taking and for the more general issue of adolescent risk taking are discussed.

1. Introduction

While adolescence is a period of peak health for most, it is also a time of increased risk-taking for many. Preventable factors such as injuries (primarily traffic incidents), drug use and sexual risk-taking are the leading causes of death among young people across the world (Blum and Nelson-Mmari, 2004). Young people are involved in a disproportionate amount of road traffic accidents with Hedlund (2008) reporting that while 16- to 20-year olds made up just over 6% of licensed drivers in the US, they were, as drivers, involved in almost 18% of all accidents. The human cost of these accidents is incalculable and the economic costs immense. There is no shortage of explanations for young people's involvement in such a disproportionate amount of road traffic accidents and suggested interventions are just as varied. One such explanation stems from a widespread belief, often discussed by the media, that adolescents take more risks and that this stems from their inability to understand risk or from feelings of their own invulnerability. In an interview with the political journalism organisation, Politico, executive driver of the Center for Healthcare Decisions, Marge Ginsburg, lamented the fact that young people "...don't believe they're going to die" (Lovley, 2009). Explanations such as these have led to the creation of many school-based education programmes which aim to give adolescents a greater understanding of the risk associated with behaviours such as speeding, drug use or unprotected sex.

While there is reason to believe that adolescents do indeed take more risks (see Reyna and Farley, 2006), evidence suggests that adolescents are as aware of the risks associated with their behaviours as adults are. For a number of negative outcomes, including traffic accidents, Quadrel et al. (1993) found that adolescents were no more optimistic about their own risk than their parents were. Furthermore, they found that adults were just as likely to indicate absolute invulnerability – stating that there was no chance of some negative event occurring for them. Their findings have been supported by a number of other studies of adolescent risk perception (e.g. Millstein and Halpern-Felsher, 2002; Reyna and Farley, 2006).

The apparent shortcomings of these traditional explanations have led to a growth in more developmental-based theories. In particular, Steinberg (2008) has offered what he terms a "social neuroscience" explanation of adolescent risk-taking which addresses the two most pertinent questions: why does risk-taking increase from childhood to adolescence and why does it then decrease as people transition into adulthood? Firstly, he suggests that the development of a limbic based socioemotional network, largely dopaminergic in nature, around the beginning of puberty plays a role in the rise of risk-taking behaviour. This development is thought to increase sensation-seeking through changes in reward salience; an effect which is more pronounced in the presence of peers. Towards the end of the teens and into the early 20s structural and functional changes in pre-frontal regions and the anterior cingulated cortex continue to occur (Luna et al., 2010). Steinberg states that these changes may lead to increased cognitive control which leads to a decline in rates of risk-taking behaviour. Steinberg

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suggests that it is the temporal gap between the development of each system that underlies the risk-taking trends in adolescence.

If the development of cognitive control is the basis for the reduction in risk-taking towards the end of adolescence, then differences in this ability may explain the variations in risk-taking among individuals of this age. While "cognitive control" is a relatively broad concept, a possible candidate for its elucidation is impulsivity – a construct that relates to the degree to which an individual is able to stop themselves from acting (see Arce and Santisteban, 2006, for a more detailed discussion). This trait is generally measured using standardised questionnaires such as the Barratt Impulsiveness Scale, BIS (Patton et al., 1995). Those adolescents who have scored high on such scales have been found to engage more frequently in risky sexual behaviours (Kahn et al., 2002), drug use (Stanford et al., 1996) and dangerous driving (Dahlen et al., 2005). However, the vast majority of research with high and low risk adolescents (including those mentioned above) is questionnaire-based. Aside from the usual problems associated with questionnaires-biased responding, assumed insight, etc., scores on impulsivity questionnaires may be more of a reflection of lifestyle choices than of cognitive deficits. For example, responding positively to the statement "I act on the spur of the moment" from the BIS could be indicative of a positive attitude to "living in the now" as opposed to an inability to regulate oneself. This is not just an issue with a particular question from one questionnaire; almost all impulsivity questions can have the same ambiguous interpretations. Furthermore, scores on impulsivity questionnaires have not been associated with structural or functional differences in any of the areas that have been found to development during adolescence.

Laboratory-based measures of impulsivity, many of which rely on reaction times, can overcome some of these problems. In fact, much of the evidence that supports the cognitive control aspect of developmental theories of adolescent risk-taking comes from studies comparing old and young participants on these tasks. Measures of response inhibition, thought to be an important part of impulsivity (Clark et al., 2006), do suggest that aspects of cognitive control do not fully developed until the early 20s. Adults have been found to outperform adolescents on a Go/no-go task (Rubia et al., 2006) and the peak performance on a Stop-signal task appears to be reached from about 18 years onwards (Williams et al., 1999). Similar studies employing these tasks have not all found the same behavioural results (e.g. Stevens et al., 2007), though differences in age ranges used across studies makes comparison difficult. The Go/no-go and Stop-signal tasks do differ from each other; however, they both measure participants' abilities to withhold responses and so are conceptually relevant in the investigation of cognitive control. The validity of these tasks is strengthened by findings that adults with substance-use disorder, who display overt problems with regulating their behaviour, have been found to perform poorly on these tasks (Verdejo-Garcia et al., 2008). These tasks have been associated with areas that are still undergoing development in the late teens such as the dorsolateral prefrontal cortex (Giorgio et al., 2010) and the anterior cingulate cortex (Davies et al., 2004).

As outlined above, evidence suggests that impulsivity is related to risk-taking in adolescence and laboratory measures have demonstrated that cognitive control may not have fully developed until the early 20s. However, as far as the authors are aware, no previous research has combined these methods for this age group. If cognitive control is the key factor in reducing risk-taking, then it may well be what distinguishes high and low-risk adolescents. Specifically, since dangerous driving is a problem for late rather than early adolescents, those who engage in it more frequently should have a poorer performance on laboratory-based impulsivity tasks. Furthermore, since neurodevelopment follows different trajectories for the sexes (de Bellis et al., 2001) the potential impact on response inhibition could explain the markedly different crash statistics between males and females (OECD, 2006).

2. Method

2.1. Participants and design

Participants belonged to one of two driver groups – offenders and non-offenders. The offender group was made up of 30 individuals (15 males) who were attending a speed awareness course. There were 40 participants (21 males and 19 females) in the non-offenders group. The speed awareness course is part of a UK initiative to combat dangerous driving, particularly speeding, among young people. Any drivers between the ages of 17 and 25 caught speeding for the first time are given the option of attending the course instead of receiving a fine and penalty points. The participants in the non-offenders group were (non-psychology) college students who had completed an online questionnaire and had indicated that they had never been involved in an accident and that they had no penalty points. All participants were aged between 17 and 21 inclusive with a mean age of 19 years in each group.

Participants completed two reaction-time (RT) tasks – the Go/no-go task and the Stop-signal task. The variables of interest in the Go/no-go were the RTs to Go trials and number of commission errors. For the Stop-signal task, driver groups were compared in their *Stop-signal RTs* (SSRT) and their *go RTs*. Participants also completed the Barratt Impulsiveness Scale II (BIS). Participants were paid 10 euro/pounds for their participation.

2.2. Procedure

Participants complete the two tasks below in a counterbalanced order with questionnaires administered between tasks so as to avoid any confusion regarding specific task rules.

2.2.1. Stop-signal task

In this computer-based task, participants were presented with a number of Xs and Os (one at a time). They were asked to press the 'L' key on a keyboard if an 'X' was presented and the 'Z' key if an 'O' was presented. They were told not to focus too much on the letter names of the keys, but to conceptualise the responses as 'right-hand key for X and left-hand key for O'. They were told to respond to each letter as fast as possible when it was presented on screen and were then given 10 practice trials. After these, participants were told that on some trials, the presented letter would be accompanied by an audible tone and that on these trials they should withhold their response to the letter. They were told that this tone would come at different times on different trials and that they would not be able to stop themselves from responding on all of the relevant trials. It was emphasised that they should still respond to the letters as quickly as possible. They were then given 18 practice trials within which 6 were stop trials (i.e. those accompanied by the tone). The main task came straight after these practice trials and consisted of 256 trials (128 Xs and 128 Os) and 64 of which (32 Xs, 32 Os) were stop trials. Participants were given a break half-way through. The exact details of what was presented were the same as outlined in Logan et al.'s (1997) original description of this version of the task.

2.2.2. Go/No-go task

Participants were presented with written instructions on the computer screen. For this task participants were presented with the letters X and Y which appeared one at a time in an alternating fashion (i.e. 'X, Y, X, Y, . . .'). They were instructed to push the space bar each time a letter appeared on screen. They were then told that occasionally the sequence would be broken by a letter repeating itself (e.g. 'X, Y, Y'). Participants were told that if a letter