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The effects of training impulse control on simulated driving

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ABSTRACT

There is growing interest in young driver training that addresses age-related factors, including incompletely developed impulse control. Two studies investigated whether training of response inhibition can reduce risky simulated driving in young drivers (aged 16–24 years). Each study manipulated aspects of response inhibition training then assessed transfer of training using simulated driving measures including speeding, risky passing, and compliance with traffic controls. Study 1 (n = 65) used a Go/No-go task, Stop Signal Task and a Collision Detection Task. Designed to promote engagement, learning, and transfer, training tasks were driving-relevant and adaptive (i.e. difficulty increased as performance improved), included performance feedback, and were distributed over five days. Control participants completed matching "filler" tasks. Performance on trained tasks improved with training, but there was no significant improvement in simulated driving. Study 2 enhanced response inhibition training using Go/No-go and SST tasks, with clearer performance feedback, and 10 days of training. Control participants completed testing only, in order to avoid any possibility of training response inhibition in the filler tasks. Again performance on trained tasks improved, but there was no evidence of transfer of training to simulated driving. These findings suggest that although training of sufficient interest and duration can improve response inhibition task performance, a training schedule that is likely to be acceptable to the public does not result in improvements in simulated driving. Further research is needed to investigate whether response inhibition training can improve risky driving in the context of real-world motivations for risky driving.

1. Introduction

Additional driver training is often suggested as an approach to remedy the young driver problem. However, training has traditionally focused on addressing driver inexperience and has been limited in its effectiveness (Ker et al., 2003). There is growing interest in young driver training that addresses age-related factors, including incompletely developed impulse control (Hatakka et al., 2002; Keskinen et al., 1999).

The Dual Systems Model (Steinberg, 2010) proposes that adolescents are particularly likely to engage in risky behaviour because impulse control and reward seeking develop according to different timetables. Specifically reward seeking develops according to a curvilinear function peaking between mid- to late-adolescence, impulse control develops linearly over the course of adolescence and early adulthood: "Heightened vulnerability to risk-taking in middle adolescence may be due to the combination of relatively higher inclinations to seek rewards and still maturing capacities for self-control" (p. 26).

Research generally supports the hypothesis that poor impulse control contributes to risky driving, particularly among young drivers. In studies with young drivers, more risky driving (assessed by self-reports, simulated driving, infringements) has been associated with higher self-reported impulsiveness (Constantinou et al., 2011; Dahlen et al., 2005; O'Brien and Gormley, 2013; Paaver et al., 2013; Pearson et al., 2013; Samsa et al., 2013; Treloar et al., 2012; Wickens et al., 2008), and with poorer response inhibition in relevant laboratory tasks (Hatfield et al., 2017; Jongen et al., 2011; O'Brien and Gormley, 2013). Nonetheless, some contradictory results have been reported (Jongen et al., 2011; O'Brien and Gormley, 2013; Renner and Anderle, 2000).

Thus far, approaches for addressing impulsiveness in young driver training have focussed on increasing driver's awareness of their standing on this risk factor. For example, The Goals for Driver Education (GDE) matrix (Hatakka et al., 2002) that has had a strong influence on driver education in Europe includes the goal of increasing

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"self-evaluation/awareness of personal skills for impulse control" (p. 209). Paaver and colleagues (Paaver et al., 2013) evaluated a brief lecture-based intervention that aimed to 1) describe impulsivity and its influence on risky driving; 2) suggest how to identify one's own impulsive tendencies and triggers for impulsive behaviour, and 3) suggest and practice strategies for self-monitoring and self-regulation. Compared to control participants, intervention group participants had half as many speeding violations in the year following the intervention.

Mayhew and colleagues (Mayhew and Simpson, 2002) argued that improving young driver safety "might involve moving or compressing the natural developmental process" (pp. ii4-5) – which highlights the possibility that impulse control might be trained. That is practicing impulse control may help it to develop faster than it otherwise would. At the same time the extent to which development can be influenced by experience may be limited, in keeping with the notion of a "critical stage" (Chambers et al., 2003; Johnson and Newport, 1989).

Studies that have attempted to train impulse control using extended practice of response inhibition tasks (primarily Go/No-go and SS tasks) have had mixed results. A recent review showed that some studies demonstrated improved performance on trained tasks, while others did not reveal improvement (Spierer et al., 2013).

Nonetheless, most studies that have examined transfer of impulse-control training amongst young people (e.g. undergraduate students) showed improvements in impulsive behaviour after training. Behaviours successfully modified by response inhibition training have included food consumption (Houben, 2011; Houben and Jansen, 2011; Veling et al., 2011), gambling (Verbruggen et al., 2012), alcohol consumption (Houben et al., 2011), and features of attention deficit hyperactivity disorder (ADHD) (Johnstone et al., 2012). Improvement in impulse control as a result of practice during training is one possible mechanism for these improvements in impulsive behaviour. No study has considered whether risky driving can be reduced by impulse control training.

Successful training of impulse control has been demonstrated in Go/No-go tasks in children aged 3 and 4 years (Dowsett and Livesey, 2000; Livesey and Morgan, 1991). These findings suggest that it may be possible to overcome supposed development stage limitations by training impulse control via reward and punishment contingencies.

The success of inhibitory control training may depend on tasks and training parameters (Thorell et al., 2009). Task difficulty appears to be a key component of successful training (Johnstone et al., 2012). Benikos and colleagues (Benikos et al., 2013) employed a Go/No-go task and manipulated task difficulty by using response time deadlines of 300 ms, 500 ms and 1000 ms. The moderately difficult task (response time deadline = 500 ms) produced the greatest improvement in performance, in terms of reduced Go reaction time with no change in Go/No-go accuracy. They argued that this finding is consistent with previous research showing a U-shaped relationship between performance and task difficulty.

To date, the potential to train inhibitory control in adolescents using laboratory response inhibition tasks has been limited, and the resulting effects on driving have not been examined. In the present research, we investigated whether targeted practice (training) of different intensities on computer-based response inhibition tasks resulted in improved performance of these tasks (learning), and in less impulsive simulated driving (transfer). The success of such a transfer of response inhibition would offer a practical opportunity for improved driving safety for young drivers.

2. Study 1

Study 1 followed from a pilot study in which training participants completed a single session of either 600 or 1200 trials of a Go/No-go task that used letter-based stimuli, and around 6% No-go trials. Task parameters were based on those employed for Benikos et al (2013) moderate difficulty task. For both training groups there was a linear increase in No-go % commission error, and no change in Go RT, relative to a group that completed filler (Choice Reaction Time) task. This deterioration in training task performance may have reflected frustration or fatigue. Unsurprisingly, training participants showed no reduction of risky driving during the simulated driving tests that followed training (relative to control participants).

Study 1 aimed to evaluate training that was intended to be more intensive, less difficult, and more engaging than the training employed in the pilot study. First, three different training tasks were employed with each participant, in an effort to make training less monotonous and more engaging. The use of different tasks may also contribute to different aspects of impulse control being addressed, and so promote transfer. Second, each task employed driving-related stimuli, in order to increase the likelihood of transfer to the simulated driving test (Schmidt, 1987). Third, the percentage of trials requiring participants to inhibit responding was increased to multiply opportunities for learning. Fourth, two of the three tasks were adaptive, in the sense that task difficulty increased as performance improved (and decreased if performance dropped off). This allowed task difficulty to be continuously adjusted for each individual. It has been recognised that matching the difficulty of training exercises to performance can enhance learning (Butler and Winne, 1995). Johnstone and colleagues (Johnstone et al., 2012) have had some success in training impulse control using adaptive tasks.

Training was also enhanced by delivering it across five daily sessions, and by incorporating performance feedback and performance incentives. Distributing training over several days has been found to accelerate skill acquisition (Baddeley and Longman, 1978; Rohrer and Taylor, 2006). Performance feedback serves to promote learning by providing information about appropriate responding and potentially reinforcing correct responses (Goodman, 1988). Feedback has been included as an important component of models of young driver accident involvement (Gregersen and Bjurulf, 1996) and has been demonstrated to improve driving performance for young drivers. For example, Donmez et al. (2007) showed that real-time feedback resulted in young drivers engaging less with in-vehicle distractions. Krasnova et al. (2015) showed summary feedback about their performance during a simulator drive improved speed management performance by young drivers.

A "Performance Compensation Scheme" was introduced to increase motivation (to perform well during the tasks, and to complete the training). Participants were informed that in addition to the compensation for completing the laboratory days, graduated "bonus" payments would be made to participants in the top 10% (AUD20), 11–20% (AUD15) 21–30% (AUD10) and 31–50% (AUD5) of training task performance.

2.1. Methods

2.1.1. Design

Study 1 employed the between-subjects repeated-measures design depicted in Table 1. On each of five consecutive days participants in the Training Group completed three tasks (a Go/No-go task, a Stop Signal Task (SST), and a Collision Detection Task). Participants in the Control Group completed a parallel schedule of filler tasks that used comparable stimuli but without the "response inhibition" element (as described in Section 2.1.3). The order of training tasks was counterbalanced between participants and across days (five orders). All participants completed a simulated drive before their training tasks on Day 1, and after their training tasks on Days 3, and 5. Three versions of the simulated drives were counterbalanced between participants and across days (three orders).

2.1.2. Participants

Participants were recruited to a study on "driving performance" for compensation of AUD54 (plus possible bonus payments) using a