Accident Analysis and Prevention 109 (2017) 70–77

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Hazard perception skills of young drivers with Attention Deficit Hyperactivity Disorder (ADHD) can be improved with computer based driver training: An exploratory randomised controlled trial

C.R. Bruce[a,*], C.A. Unsworth[a,b,c,d], M.P. Dillon[e], R. Tay[f], T. Falkmer[d,g], P. Bird[h], L.M. Carey[a,i]

[a] Occupational Therapy, School of Allied Health, La Trobe University, Melbourne, VIC, 3086, Australia
[b] Occupational Therapy, School of Health, Medical and Applied Sciences, CQUniversity, 120 Spencer St, Melbourne, VIC 3000, Australia
[c] Jönköping University, Gjuterigatan 5, Box 1026, 551 11, Jönköping, Sweden
[d] School of Occupational Therapy and Social Work, Faculty of Health Sciences, Curtin University, GPO Box U1987, Perth, WA 6845, Australia
[e] Prosthetics and Orthotics, School of Allied Health, La Trobe University, Melbourne, VIC, 3086, Australia
[f] School of Business IT & Logistcs, RMIT University, Melbourne, VIC 3000 Australia
[g] Rehabilitation Medicine Unit, Department of Medicine and Health Sciences (IMH), Faculty of Health Sciences, Linköping University & Pain and Rehabilitation Centre, SE-581 83, Linköping, Sweden
[h] The Gosforth Clinic, PO Box 680, Maroochydore QLD 4558, Australia
[i] The Florey Institute of Neuroscience and Mental Health, Neurorehabilitation and Recovery, 245 Burgundy Street, Heidelberg, Melbourne, VIC 3084, Australia

ARTICLE INFO

Keywords:
Attention deficit hyperactivity disorder
Driving
Hazard perception
Traffic hazard

ABSTRACT

Background: Young drivers with Attention Deficit Hyperactivity Disorder (ADHD) are at higher risk of road traffic injuries than their peers. Increased risk correlates with poor hazard perception skill. Few studies have investigated hazard perception training using computer technology with this group of drivers.
Objectives: *Determine the presence and magnitude of the between-group and within- subject change in hazard perception skills in young drivers with ADHD who receive Drive Smart training. *Determine whether training-facilitated change in hazard perception is maintained over time.
Methods: This was a feasibility study, randomised control trial conducted in Australia. The design included a delayed treatment for the control group. Twenty-five drivers with a diagnosis of ADHD were randomised to the Immediate Intervention or Delayed Intervention group.The Immediate Intervention group received a training session using a computer application entitled Drive Smart. The Delayed Intervention group watched a documentary video initially (control condition), followed by the Drive Smart computer training session. The participant's hazard perception skill was measured using the Hazard Perception Test (HPT).
Findings: After adjusting for baseline scores, there was a significant betweengroup difference in post-intervention HPT change scores in favour of the Immediate Intervention group. The magnitude of the effect was large. There was no significant within-group delayed intervention effect. A significant maintenance effect was found at 6-week follow-up for the Immediate Intervention group.
Conclusions: The hazard perception skills of participants improved following training with large effect size and some maintenance of gain. A multimodal approach to training is indicated to facilitate maintenance. A full-scale trial is feasible.

1. Introduction

Adolescent male drivers in the 16–19 year age group have a nine-fold increase in their crash risk (relative risk [RR], 9.8 [CI not available]) (Elvik et al., 2009). During the novice driver period (i.e., usually middle adolescence until a driver licence has been held for two years), there is an increased crash risk compared to after this period (Elvik et al., 2009). Driving eventually improves and becomes an overlearned skill (Fox et al., 1998); that is, it no longer requires controlled cognitive processing (Shinar et al., 1998).

One distinct group of young drivers, those with Attention Deficit Hyperactivity Disorder (ADHD), are recognised as being at additional crash risk relative to their aged matched counterparts. The RR for drivers diagnosed with ADHD is 1.36, 95% CI 1.18, 1.57 and the presence

* Corresponding Author.
E-mail addresses: C.Bruce@latrobe.edu.au (C.R. Bruce), c.unsworth@cqu.edu.au (C.A. Unsworth), Michael.Dillon@latrobe.edu.au (M.P. Dillon), richard.tay@rmit.edu.au (R. Tay), T.Falkmer@curtin.edu.au (T. Falkmer), admin@gosforthclinic.com.au (P. Bird), L.Carey@latrobe.edu.au (L.M. Carey).

http://dx.doi.org/10.1016/j.aap.2017.10.002
Received 22 March 2017; Received in revised form 5 June 2017; Accepted 3 October 2017

of comorbid behavioural problems such as Oppositional defiant disorder, further increases the RR to 1.86, 95% CI,1.27, 2.75 (Vaa, 2014).

ADHD is the most common disorder of neural development in children (Rowland et al., 2002). The worldwide-pooled prevalence of ADHD is approximately 5% (Polanczyk et al., 2007). In males, the prevalence rate can be as high as 9% (Szatmari et al., 1989). Females with ADHD are identified less often as they more typically present with less disruptive behaviour (Berry et al., 1985). Executive dysfunction is a common sequela of ADHD (Barkley, 1997).

Executive function is crucial for safe driving, given the need to be able to plan and take evasive action (Groeger, 2000). Impaired executive function in people with ADHD may reflect poor behavioural or response inhibition. This may be associated with secondary problems such as poor working memory (Barkley, 1997). These problems with executive function in young drivers often manifest as risk-taking behaviour (Jonah, 1986) and poor hazard detection (Mckenna and Horswill, 1999; Cox and Taylor Davis, 2009).

Risk-taking behaviour in adolescence, such as reckless driving and substance misuse, can be deleterious to health. This behaviour may increase in the presence of peers (Steinberg, 2007). Such behaviours can also increase in the presence of ADHD (Richards et al., 2002; Devito et al., 2008) due to an immature cognitive-control network. Frontal lobe maturation is implicated in cognitive-control and is reported to be delayed in the setting of ADHD (Giedd and Rapoport, 2010). However less is known about the extent of hazard perception skill impairment and reaction time in drivers with ADHD.

Research has demonstrated that hazard perception latency can be improved in this group of drivers using computer training software (Poulsen et al., 2010). Understanding risk and having well developed hazard perception skills are requisite for managing danger in the traffic environment (Horswill and Mckenna, 2004; Brown and Groeger, 1988); the latter correlating with crash risk (Mckenna and Horswill, 1999). Given the established link between hazard perception and crash risk, this research seeks to establish if the hazard perception skills of young drivers with ADHD can be improved with intervention.

Several studies have investigated the benefits of pharmacological treatment to ameliorate the executive dysfunction that affects drivers with ADHD (Cox et al., 2004; Cox and Taylor Davis, 2009). However, stimulant medication adherence is poor (Firestone, 1982; Perwien et al., 2004), with young people at particularly high risk for non-compliance (Marcus et al., 2005). Moreover a structured interruption of a pharmacological treatment (drug holiday) is commonly used to control adverse side effects, and monitor effectiveness (Graham et al., 2011). Although a number of factors relate to crash risk, such as the influence of passengers and the time of day, 'drug holidays' also coincide with disproportionately high crash rates on weekends in young males (Doherty et al., 1998).

While drug treatments may improve driving safety by reducing impairments associated with ADHD, a more holistic approach that improves driver skills may also be of benefit. There is growing evidence that video and computer-based training improves performance on hazard perception tests in both an ADHD population and healthy individuals (Pradhan et al., 2009; Isler et al., 2009; Poulsen et al., 2010; Bruce et al., 2014). Various forms of training, such as Drive Smart (Regan et al., 2000), have been designed to expedite the development of driver-related cognitive perceptual skills. Drive Smart uses simulation-based research and was created in conjunction with an aviation and defence simulation developer (Triggs and Regan, 1998).

The approach to developing Drive Smart was based on risk perception (ability to detect, perceive and assess risk); attention control (ability to prioritise attention); time-sharing (sharing available processing time between multiple driving tasks) and calibration (moderation of task demands according to performance capacity) (Triggs and Regan, 1998). Results from a simulator-based evaluation of Drive Smart suggested that it is effective in training attention control and risk perception skills (Regan et al., 2000). As a skill-based therapy, Drive Smart may be a plausible adjunct to pharmacological intervention for young drivers with ADHD.

The current research investigates the feasibility and explores the potential effectiveness of a non-pharmacological intervention for drivers with ADHD − skill based training of attention control and hazard perception skills using computer-based training. The primary outcome of the effect of the intervention will be a reduction (improvement) in hazard perception response time. Moreover, this study addresses a gap in the literature by reporting 6-week follow-up data to establish if changes observed are maintained over time. These data will enable sample size calculation and determine recruitment strategy for a full-scale evaluation of Drive Smart training.

The primary aim of this study was to pilot test a computer-based driver training program, Drive Smart, for young drivers with ADHD to:

- determine the presence and magnitude of a between-group difference in change in hazard perception skills (primary outcome), in young drivers with ADHD who receive Drive Smart training compared to a control intervention.
- determine the within-group change in hazard perception skills between control and delayed intervention phases in the Delayed Intervention group.
- determine whether training-facilitated change in hazard perception is maintained over time.

As a pilot, feasibility study we also aimed to:

- estimate the magnitude and variance of within-subject change in hazard perception skills pre-post intervention to enable sample size calculation for a future larger randomised controlled trial (RCT).
- determine the rate of recruitment and retention of participants in order to establish if a full scale evaluation of Drive Smart is feasible.

2. Methods

2.1. Trial design

This was a multicentre, randomised (1:1), controlled, parallel group, exploratory study conducted in Australia (2 sites). Participants were randomly assigned to either the Immediate Intervention group or a Delayed Intervention group. Participants allocated to the Delayed Intervention group first received the control condition followed by the Drive Smart intervention (Fig. 1). To improve recruitment and achieve a pilot trial of viable size, we made some changes to the study method. For example, we changed the trial from single-centre to multi-centre. See Australian New Zealand Clinical Trials Registry − http://www.anzctr.org.au for details (Trial Id: ACTRN12612000718842).

2.2. Participants

Human ethics approval was granted from La Trobe University before commencement of data collection (approval number: 12-092). Participants provided informed written consent. Eligible participants were aged 16–25 years, English speaking (in order to understand Drive Smart instructions), had a confirmed ADHD diagnosis (confirmed in writing by treating doctor), and had some driving experience (self-reported). Eligible participants had no previous experience using computer based driver training software. Participants were recruited using direct advertising (newspapers, internet, bulletin boards, posters) and social media e.g., https://drivingsafeblog.wordpress.com/. Advertisements were placed through various ADHD support groups, secondary schools and technical and further education institutions. Prospective participants were also contacted at a specialist clinic in Queensland, Australia. In the first instance, participants were screened via telephone for eligibility against the inclusion criteria.