ARTICLE IN PRESS

Transportation Research Part F xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Transportation Research Part F

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

Driving speed choice: The role of conscious monitoring and control (reinvestment) when driving

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ARTICLE INFO

Article history:
Received 9 February 2017
Received in revised form 10 May 2017
Accepted 7 June 2017
Available online xxxx

Keywords:
Everyday driving
Decision specific reinvestment
Movement specific reinvestment
Speed choice
Conscious processing

ABSTRACT

This study aimed to examine the role of reinvestment - the propensity to consciously monitor and control actions (movement specific reinvestment) and to consciously monitor and evaluate decision making processes (Decision specific reinvestment) while driving in everyday risky scenarios. The study also aimed to evaluate the association between reinvestment and previously validated driver attitude measures. Fifty one participants completed a series of questionnaires (Driving Self-Efficacy Scale, Driver Attitude Questionnaire, Movement Specific Reinvestment Scale, Decision Specific Reinvestment Scale) after which they completed a test phase in a driving simulator. In the test phase, driving scenarios included roads with different markings (i.e., double yellow, wide centrelines, wire rope barriers, Audio Tactile Profiled markings) and alerting scenarios (i.e., police car present, high crash risk area sign, reduced speed zone). Results revealed that on risky roads (wide centrelines), participants with a high propensity for decision specific reinvestment drove slower than those with a low propensity. Driver experience, attitudes towards speeding and scores on the Decision Reinvestment subscale of the Decision Specific Reinvestment Scale significantly predicted speed choice. More experienced participants with higher scores on the Decision Reinvestment subscale were more likely to drive slower and participants with worse attitudes towards speeding were likely to drive faster. Participants with a low propensity for movement specific reinvestment (specifically, Movement Self-Consciousness) reduced their speed to a greater extent than those with a high propensity when driving in the police car scenario. There was some evidence to suggest that high decision specific and movement specific reinvesters were more likely to be involved in crashes and receive driving infringements. The current study is the first to demonstrate a significant relationship between reinvestment and driving. The implications of these findings for road safety are discussed.

1. Introduction

Driving, like other well-learned skills is often carried out without consciously processing information about the step-by-step processes involved in skill execution. It is not uncommon to drive from one location to the next without remembering

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http://dx.doi.org/10.1016/j.trf.2017.06.006
1369-8478/

Please cite this article in press as: Malhotra, N., et al. Driving speed choice: The role of conscious monitoring and control (reinvestment) when driving. *Transportation Research Part F* (2017), http://dx.doi.org/10.1016/j.trf.2017.06.006

certain sections of the journey or at times the entire journey. Researchers have referred to this phenomenon as driving on 'auto-pilot', 'highway hypnosis' (Williams, 1963), driving without attention (Kerr, 1991) and driving without awareness (Brown, 1994).

Driving in an automatic manner is a hallmark of expertise according to most theories of skill acquisition. Inevitably, the theories propose that skills that are initially carried out in a controlled manner, with heavy reliance on declarative knowledge, are performed in a proceduralized, automatic or implicit manner, with little reliance on declarative knowledge, if they are well practiced (Anderson, 1982; Fitts & Posner, 1967; Reber, 1989). For instance, learning how to drive requires attention resources to process rules about technical skills like steering (hands in the quarter to three position), speed control (braking, gearing down) and for non-technical skills such as decision-making (e.g., gap selection). With practice it is expected that technical skills (e.g. steering, braking, changing gears) become proceduralized. Charlton and Starkey (2013) found that extensive practice in a driving simulator daily along the same route over 3 months, resulted in less reported difficulty, and lower variability in speed and lateral position, which were construed as signs of automaticity. Evidence of automaticity was not limited to motor skills but also cognitive skills, with drivers more accurate and efficient at a target (Volkswagen "beetle") detection task.

Once a set of skills is automatized, they are no longer continuously governed by conscious processes, which may explain why skilled drivers sometimes experience a state of 'driving without awareness'. However, under exceptional circumstances (e.g., driving unfamiliar or challenging routes) drivers may switch to a more controlled conscious mode of driving. This processing shift has been described as returning from a 'time gap experience' (Chapman, Ismail, & Underwood, 1999) or switching from a monitoring to an operating process (Charlton & Starkey, 2011; Charlton & Starkey, 2013). Evidence from other disciplines suggests that this shift can be triggered by factors in the environment (e.g., psychological pressure) but might also be determined by individual differences in the predisposition to consciously monitor and control actions (i.e., reinvestment). The Theory of Reinvestment suggests that automatized performance can be 'de-automatized' when individuals attempt to consciously monitor and control their actions using declarative knowledge accrued during the early stages of learning (Masters, 1992; Masters & Maxwell, 2008; Masters, Polman, & Hammond, 1993). The retrieval and processing of declarative knowledge to consciously monitor and control actions places demands on working memory, a limited capacity cognitive system associated with recall, maintenance and manipulation of knowledge (Baddeley, 2003). Previous studies have found that people with a high propensity to engage in conscious monitoring and control (high reinvesters) tend to perform slower under pressure than low reinvesters (Kinrade, Jackson, & Ashford, 2010), possibly because reinvestment is a time consuming process.

The propensity to reinvest can be quantified using a psychometric scale, the Reinvestment Scale, which has been shown to predict poor performance under exceptional circumstances, such as psychological pressure in laboratory settings (Chell, Graydon, Crowley, & Child, 2003; Jackson, Ashford, & Norsworthy, 2006; Masters et al., 1993; Maxwell, Masters, & Poolton, 2006) or in field settings (Jackson, Kinrade, Hicks, & Wills, 2013). More recently, the Movement Specific Reinvestment Scale (MSRS) has been developed to specifically relate to movements and consists of two factors, Conscious Motor Processing (CMP), which characterizes an individual's propensity to consciously monitor and control movements, and Movement Self-Consciousness (MS-C), which characterizes an individual's propensity to be self-conscious of their movements. Populations likely to be consciously aware of their movements, such as elderly fallers (Wong, Masters, Maxwell, & Abernethy, 2008), people with injuries (Selfe et al., 2015) and stroke patients (Orrell, Masters, & Eves, 2009), typically score higher on the MSRS than age-matched controls. Movement specific reinvestment has also been shown to play a role in skill learning and performance under pressure in safety-critical laparoscopic surgery skills (Malhotra, Poolton, Wilson, Fan, & Masters, 2014; Malhotra, Poolton, Wilson, Ngo, & Masters, 2012). Specifically, Malhotra et al. (2012) found that trained medical students with a high propensity for movement reinvestment were unable to meet task demands under time pressure because of the attentional demands placed on working memory by consciously attempting to control their movements.

Performance of complex skills, whether for sports or driving requires the successful implementation of motor and cognitive skills (decision-making) in tandem. Thus, Kinrade and colleagues developed the Decision Specific Reinvestment Scale (DSRS, Kinrade, Jackson, Ashford, & Bishop, 2010), which is comprised of two factors. Decision Reinvestment reflects a person's tendency to consciously monitor the decision-making process and Decision Rumination reflects a person's tendency to think about poor decisions made in the past. Validation of the DSRS revealed that it could accurately identify sportspersons who were more likely to make poor decisions under pressure. The predictive validity of the DSRS has been established using perceptual judgment tasks (Kinrade, Jackson, & Ashford, 2015) and in 'real-world' sports contexts (Jackson et al., 2013).

Research has identified external factors that might cause a shift from automatic to a controlled mode of performance (similar to earlier stages of learning), such as driving through an unfamiliar route or executing a difficult manoeuvre (Charlton & Starkey, 2013). However, there is no research examining individual differences in the propensity to engage in conscious control of driving. Psychological scientists have strongly recommended considering interindividual differences when examining skilled performance to gain insight into the best interventions, rather than assuming a one-size-fits all approach (Laborde & Allen, 2016; Vogel & Awh, 2008).

Although reinvestment is considered a personality trait, it is assumed to be elicited in specific situations, especially those in which the task demands are high (Malhotra, Poolton, Wilson, Omuro, & Masters, 2015; Masters & Maxwell, 2008). In everyday driving, task demands might increase in scenarios that are perceived as high risk. In particular, road features like width, horizontal alignment, centreline and edgeline markings and alerting signs, such as the presence of a police car, have been shown to have higher perceived risk ratings (Charlton & Starkey, 2016; Charlton, Starkey, Perrone, & Isler, 2014; Godley,

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