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The relation between self-reported driving style and driving behaviour. A simulator study

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ABSTRACT

The aim of this study was to investigate the predictive value of the Multidimensional Driving Style Inventory (MDSI) for driving behaviour in a driving simulator, in terms of speeding, braking, steering, lateral positioning and maintaining distance to a preceding vehicle. Eighty-eight participants, mainly from the Netherlands and Belgium, filled in the MDSI and drove in a simulator for thirty minutes. Different driving behaviours, including complying with the maximum speed, lateral position and the distance to preceding vehicles, were recorded. The objective data retrieved from the simulator were compared with scores resulting from the questionnaire data. The analysis revealed modest correlations between the self-reported driving styles and the driving behaviour in the driving simulator, similar to those reported in the literature. It is concluded that the current study supports the use of the MDSI as a diagnostic tool for screening participants with different driving styles for simulator studies.

1. Introduction

From observations of everyday traffic it is clear that not all drivers behave in the same way. Research on differences between drivers has confirmed the existence of individual differences between drivers. The choice of driving speed, distance to a preceding vehicle, overtaking other vehicles and the tendency to commit traffic violations (Elander, West, & French, 1993) constitute behavioural tendencies of drivers. These habits are usually referred to by the term 'driving style' (Ishibashi, Okuwa, Doi, & Akamatsu, 2007). Accordingly, drivers are typically characterised as, for instance, careful, risky or anxious drivers (Taubman-Ben-Ari, Mikulincer, & Gillath, 2004). From a personal, interpersonal and societal perspective, some of these driving styles are less desirable, so that it is attractive to explore ways to influence the concerned drivers to change their driving style. As part of a project in which we develop and evaluate such personalized interventions aiming to influence drivers to exhibit desirable driving behaviour, we need ways to identify people's driving styles. While for real-life situations the concerned drivers should be identified preferably from behavioural indices, for testing the effectiveness of the interventions in the laboratory, participants representing particular driving styles may be recruited by means of a questionnaire (Hooft van Huysduynen, Terken, Martens, & Eggen, 2015; Sundström, 2008; Taubman-Ben-Ari et al., 2004) as a questionnaire is, among other things, easy and cheap to administer to a larger group of respondents. Several self-report measures of driving behaviour, style and cognition have been constructed and validated over the last couple of decades. Nonetheless, the use of self-reported measures has been questioned due to the possibility of reporting biases (af Wåhlberg, 2009; af

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Wåhlberg & Dorn, 2015). This raises the question of whether a questionnaire is a proper means to identify a person's driving style, or whether driving style can better be measured from, for example, driving behaviour within a driving simulator. The aim of the current study was to determine whether the outcomes of a driving style questionnaire are in agreement with the driving behaviour.

While several driving style questionnaires have been created, the current study uses the MDSI questionnaire for collecting self-report driving style data (Hooft van Huysduynen et al., 2015). The MDSI (Taubman-Ben-Ari et al., 2004) adapted items from several other existing surveys, such as the Driver Behaviour Inventory (DBI) (Gulian, Matthews, Glendon, Davies, & Debney, 1989), the Driver Behaviour Questionnaire (DBQ) (Reason, Manstead, Stradling, Baxter, & Campbell, 1990), the Driver Behaviour Questionnaire (Furnham & Saipe, 1993) and the Driver Style Questionnaire (DSQ). Additionally, original items were created to complete the questionnaire (Taubman-Ben-Ari et al., 2004). A modified version of the MDSI questionnaire was used in the current study, which resulted from a validation study with mainly Dutch and Belgian respondents, and which contains 37 items that distinguish six of the original eight driving styles (Hooft van Huysduynen et al., 2015). (1) *Angry driving* is characterised by swearing, making more use of the horn in the vehicle or beaming to other road users. Aggression to other road users is often referred to as road rage, affecting the driver's performance and safety on the road (Galovski & Blanchard, 2004). Road rage is seen as a threat to driving, next to drinking and not using a seatbelt (Jeon, 2015). (2) *Risky driving* is characterised by speeding and the excitement of dangerous driving. Some drivers drive at a higher speed for the thrill and sensation as a part of their attitude towards taking risks (Hatfield & Fernandes, 2009). Male adolescents are more likely to engage in undesirable driving behaviour and tend to be more impulsive (Starkey & Isler, 2016) (3) *Anxious driving* is characterised by feeling distressed and worried while driving. According to Gwyther et al. (Gwyther & Holland, 2012) drivers who are less confident or more anxious tend to over-regulate driving, which can result in maladaptive responses. (4) *Dissociative driving* is characterised by inattentiveness. This may result in errors in gear shift or unawareness of still driving with lights on full beam. Inattention can also result in abrupt braking as the driver was unaware of the deceleration of a vehicle in front of him (Qu, Ge, Zhang, Zhao, & Zhang, 2015; Taubman-Ben-Ari et al., 2004). (5) *Careful driving* is characterised by calm driving and safe speed. Murphey et al. (Murphey, Milton, & Kiliaris, 2009) classified calm drivers as drivers who anticipate other road users' movements, traffic lights and speed limits. When the road conditions are perceived to be more dangerous, drivers will adapt their behaviour accordingly (Stanton & Marsden, 1996). (6) *Distress-reduction driving* is characterised by the tendency to be engaged in relaxing activities allowing drivers to reduce stress, for example, listening to music.

Multiple studies have looked into the relation between self-reported driving behaviour and actual behaviour, both in vehicles and driving simulators. In summarising the literature, we will report correlations as $r_{vehicle}$ and $r_{simulator}$, indicating whether the correlations between self-reported driving behaviour and actual behaviour stem from studies employing a vehicle or a driving simulator, respectively. A recent study by Helman and Reed (Helman & Reed, 2014), employing both a vehicle and a driving simulator study, showed significant correlations ranging between .38 and .48 between the Violations scale of the Driver Behaviour Questionnaire (DBQ) (Reason et al., 1990) and the driving speed. The findings of their study indicate that the Violations scale of the DBQ has predictive value for the speed choice in both an instrumented vehicle and in a driving simulator. A study conducted by Amado, Arıkan, Kaça, Koyuncu, & Turkan (2014) reported significant correlations between the DBQ scale Violations/Errors and observed speed errors ($r_{vehicle} = -.24$), traffic light errors ($r_{vehicle} = -.33$), clearance and checking errors ($r_{vehicle} = -.18$) and brake and gear errors ($r_{vehicle} = -.30$) reported by an independent expert observer during an on-road driver assessment. Ishibashi et al. (Ishibashi et al., 2007) developed the Driving Style Questionnaire (DSQ) and examined the external validity of the questionnaire through analysis of on-road car-following behaviour at low speed. The findings showed a positive relationship between some of the driving style scores resulting from the questionnaire and the use of the gas pedal when decelerating. For example, confidence in driving skill was positively correlated with the use of the gas pedal when driving between 4 and 20 km/h ($r_{vehicle} = .59$) and when driving between 21 and 40 km/h ($r_{vehicle} = .70$). West, French, Kemp, & Elander (1993) examined how well characteristics of self-reported behaviour related to behaviour reported by an observer who sat next to the participants in the vehicle and their results indicated that self-reported speed could be used to replace direct observations of speed. This was indicated for example by positive correlations between self-reported speed and average speed measured on two stretches of the motorway ($r_{vehicle} = .55$ and $r_{vehicle} = .65$). Next to speed, their results showed modest significant correlations between self-reports of deviant driving behaviour and observer reports of attentiveness and carefulness ($r_{vehicle} = .29$ and $r_{vehicle} = .38$, respectively). Taubman-Ben-Ari, Eherenfreund – Hager, & Prato (2016) found that risky event rates recorded with an in-vehicle data recorder were correlated significantly with the scores of four driving styles measured by the Multidimensional Driving Style Inventory (MDSI) (Taubman-Ben-Ari et al., 2004), correlating positively with the reckless-careless and the angry-hostile driving styles and negatively with the anxious and the careful-patient styles. Farah, Bekhor, Polus, & Toledo (2009) found a correlation between the MDSI score for the hostile driving style and passing gaps ($r_{simulator} = -.20$) and speed ($r_{simulator} = .32$) in a driving simulator experiment.

As was mentioned above, differences in driving style typically relate to behaviours such as speeding, traffic light errors/violations, manner of acceleration/deceleration, distance to preceding vehicles, errors in gear shift and abrupt braking due to inattentiveness. For the current research, we focus on measures related to speed and distance, in particular, average speed and speed variability, jerk, deceleration and distance to a preceding vehicle, as these measures (1) can be gained directly from the vehicle and (2) be measured continuously. Further evidence that these measures are indicative of driving style is available from the literature. Average speed, speed variability and faster accelerations and decelerations have been linked