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Accidents, aberrant behaviours, and speeding of young moped riders

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ABSTRACT

Moped riders, particularly youngsters, are amongst the highest risk group in traffic. We used an adapted version of the Driver Behaviour Questionnaire to examine why moped riders are often involved in traffic accidents. We conducted a questionnaire study among 146 young moped riders in the Netherlands. We found that aberrant behaviour of moped riders can indeed be classified as errors, lapses, and violations. Accidents involvement appeared not to be significantly related to errors, lapses, and violations. As hypothesised, moped riders were more likely to speed, and had a stronger intention to disobey speed limits when they have a positive attitude towards speeding, and when they think that others expect them to speed. Perceived control did not affect self-reported speeding and intention to speed. We discuss the theoretical and practical implications of our study.

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1. Introduction

In many European countries, moped riders are amongst the highest risk group in traffic. In Western Europe, about 2500 moped riders die in traffic each year (Noordzij, Forke, Brendicke, & Chinn, 2001). In the Netherlands, mopeds are one of the most unsafe modes of transport (Statistics Netherlands, 1998). A moped rider is 40 times more likely to be involved in a traffic accident than a car driver, while the risk to get injured per kilometre driven is about 100 times higher compared to a car driver (Adviesdienst Verkeer en Vervoer, 2004). Young moped riders are particularly a high risk group (e.g., Murray, 1998). High risks for young moped riders have also been reported for other European countries, among which Germany, France, and Switzerland (Hubacher & Ewert, 1995; Noordzij et al., 2001; Steffens, Gawatz, & Wilmes, 1988), and India (Dandona, Kumar, & Dandona, 2006). In Norway, moped injuries accounted for a majority of traffic injuries among persons aged 16 and 17 years (Kopjar, 1999). Moped injuries are probably more frequent than appears from official statistics (as is true for car drivers). For example, in Norway, only 40% of moped injuries were reported in official statistics (Kopjar, 1999). These statistics suggest that prevention of moped injuries requires significant research activity (cf. Kopjar, 1999). In the province of Drenthe, The Netherlands, moped riders are involved in 8% of the accidents reported, and in 22% of the personal injury accidents in 2002. In total 76% of the moped riders' accidents involved a conflict with a car (of which 51% was caused by moped riders), 1% involved a conflict with a truck (of which 59% was caused by moped riders), 13% with a bicycle (of which 41% was caused

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by moped riders), 4% with another moped, and 6% involved a one-sided collision (Van Brussel, 2005). About 44% of the moped riders' accidents was due to not giving right of way, 23% to not providing a way through, 12% to not keeping sufficient distance, and 9% to dangerous overtaking (Van Brussel, 2005). Compared to other road users accidents, moped riders' accidents are more often caused by not providing a way through (23% for moped riders, 7% for all road users), and less often by not keeping sufficient distance (1% for moped riders, 26% for other road users; Van Brussel, 2005).

Various policies have been proposed and implemented to reduce traffic risks of and injuries among moped riders. Some policies aim to reduce the seriousness of injuries, such as the mandatory use of safety helmets in many countries (Kopjar, 1999). Other measures are aimed at reducing accident risks by enhancing the knowledge and skill level of moped riders. For example, in the Netherlands, as of 1996, moped riders are required to pass a theory test to gain a moped certificate. Although this policy measure resulted in an increase in knowledge levels, it did not result in a reduction of accident involvement of moped riders (Goldenbeld, Twisk, & De Craen, 2004; Van Schagen, 2000). Also, a trial with a practical moped riding training course in the Netherlands revealed that this training did not result in improved driving skills in the long term (Goldenbeld et al., 2004). Although the training group did perform better right after the training, the control group did catch up soon, indicating that performance increases anyway with experience (Goldenbeld et al., 2004, see also Steffens et al., 1988). Also, the moped riders that improved most from the training course in the short term showed a considerable decline in performance in the longer term. This suggests that other factors influence traffic risks and accident involvement of young moped riders.

As yet, only few studies explicitly addressed factors influencing accident involvement of young moped riders and strategies to reduce accident risks. In order to design effective policies to reduce risks and accident involvement of young moped riders, one needs to understand which behaviours cause these risks and accidents, and which factors influence the relevant behaviours. This study aims to examine why young moped riders are often involved in traffic accidents. More particularly, we investigate to what extent accident involvement of moped riders is related to three types of aberrant behaviour, that is, behaviour that deviates from normal practices that increase the risk of traffic crashes: errors, lapses and violations. We will also study factors influencing violations of moped riders, in particular speeding offences.

1.1. Errors, lapses, and violations

Various instruments have been proposed to assess driving style, and relationships between driving style and accident involvement. One of the most influential frameworks has been proposed by Reason, Manstead, Stradling, Baxter, & Campbell (1990). They distinguished three types of behaviours that increase the risks of being involved in an accident: errors, lapses and violations. These have different psychological origins and should be changed in different ways. Errors refer to occasions in which a planned sequence of activities fails to achieve its intended outcome; they reflect driving mistakes involving failures of observation and misjudgement, such as breaking too quickly on a slippery road or misjudging the crossing interval when turning (Reason et al., 1990). Lapses refer to attention and memory failures that are relatively harmless, such as hitting something when reversing that you had not seen or attempting to drive away from traffic lights in the wrong gear. Lapses are unlikely to influence driving safety. Violations refer to deliberate deviations from normal safe driving practices (Reason et al., 1990), these may be deviations from formal prohibitions as well as from unofficial local norms of what is deemed to be safe or acceptable (Åberg & Rimmö, 1998). Examples are speeding or overtaking on the inside. Errors and lapses are related to cognitive processes of the individual and are generally not deliberate actions¹ (Åberg & Rimmö, 1998), whereas violations result from motivational processes and deliberate actions (cf. Reason et al., 1990).

Reason and colleagues developed the Driver Behaviour Questionnaire (DBQ) to measure errors, lapses, and violations. The distinction between errors, lapses, and violations has been validated in various studies (e.g., Elliot, Baughan, & Sexton, 2007; Kontogiannis, Kossiavelou, & Marmara, 2002; Parker, Reason, Manstead, & Stradling, 1995; Reason et al., 1990; Åberg & Rimmö, 1998), although the factor structure differed slightly across studies. Some studies found a distinction between normal highway code violations and violations of generally accepted driving norms involving some kind of aggression (e.g., Lawton, Parker, Manstead, & Stradling, 1997; Lawton, Parker, Stradling, & Manstead, 1997; Parker, Lajunen, & Stradling, 1998; Sullman, Meadows, & Pajo, 2002), or a distinction between interpersonal and speeding violations (Mesken, Lajunen, & Summala, 2002), while others reported a distinction between two types of lapses (that is, inattention errors and inexperience errors) when adding additional items (Kontogiannis et al., 2002; Rimmö & Åberg, 1999; Åberg & Rimmö, 1998). Elliot et al. (2007) developed the Motorcycle Rider Behaviour Questionnaire, including items that are specific to motorcycling, and found a distinction between traffic errors, control errors, speed violations, stunts, and use of safety equipment. A couple of studies reported larger deviations from the original factor structure (e.g., Bener, Özkan, & Lajunen, 2008; Blockley & Hartley, 1995; Davey, Wishart, Freeman, & Watson, 2007; Gras et al., 2006; Xie & Parker, 2002), suggesting that socio demographic and cultural differences may affect how different types of aberrant driving behaviour cluster.

Typically, the factor structure of the DBQ was examined by means of exploratory factor analyses (with the exception of a study by Özkan, Lajunen, Chiliaoutakis, Parker, & Summala, 2006), which is surprising given the clear theoretical basis of the

¹ In some cases errors do result from deliberate actions, for example almost go off the road because one is speeding.

DBQ. Confirmatory factor analyses would be more appropriate, in which one seeks to determine if the number of factors and the loadings of measured (indicator) variables on them conform to what is expected on the basis of pre-established theory (in this case the distinction between errors, lapses, and violations).

The DBQ proved to be predictive of accident involvement. Violations appeared to be most strongly related to crashes (e.g., Gras et al., 2006; Kontogiannis et al., 2002; Parker, Reason, et al., 1995; Reason et al., 1990; Sullman et al., 2002; Xie & Parker, 2002; Xie, Parker, & Stradling, 2002; Özkan & Lajunen, 2005; Özkan et al., 2006), but in some cases errors were related to accident involvement too (Parker, McDonald, Rabbitt, & Sutcliffe, 2000; Parker, West, Stradling, & Manstead, 1995; Rimmö & Åberg, 1999). Elliot et al. (2007) found that only errors predicted accident involvement of motorcyclists, while both violations and errors predicted crash risks for which motorcyclists accepted some degree of blame. Among elderly and female drivers, lapses were predictive of accident involvement as well (Dobson, Brown, Ball, Powers, & McFadden, 1999; Parker, McDonald, Rabbitt, & Sutcliffe, 2000). Mesken et al. (2002) found that violations predicted passive accidents, while errors predicted active accidents. In a Qatari sample, errors, lapses, as well as violations predicted accident involvement, with errors being the most critical factor (Bener et al., 2008).

The DBQ has been employed to study behaviour of car drivers, truck drivers, and motorcyclists, but to authors' knowledge, not to examine aberrant behaviour of young moped riders. We hypothesise that the distinction between errors, lapses, and violations will be found in a population of young moped riders as well (Hypothesis 1). Moreover, in line with previous studies on car drivers, we expect that accident involvement of young moped riders is most strongly related to violations (Hypothesis 2). Åberg and Rimmö (1998) found that violations were more common among young drivers than among other age groups, which will result in higher accident risks. Also, Rutter and Quine (1996) found that accident involvement of motorcycles was associated with willingness to commit traffic violations (that is, breaking the law and violating the rules of safe driving).

1.2. Factors influencing violations

Violations are deliberate actions that result from social and motivational factors. This implies that moped riders can be motivated to commit fewer violations. We will examine motivational factors influencing violations in more depth. For this purpose, we will employ the theory of planned behaviour (TPB, Ajzen, 1991) that aims to predict behaviour that is under volitional control. According to the TPB, behaviour results from an individual's intention, which reflects how much effort one is willing to take to engage in a specific behaviour. Intention depends on attitudes towards behaviour (that is, the degree to which engagement in behaviour is positively valued), subjective norms (that is, social pressure from important others to engage in or refrain from particular behaviour), and perceived behaviour control (that is, people's confidence that they are capable of performing the behaviour). The TPB has proven to be successful in explaining various types of intentions and behaviour, including driving behaviour such as aggressive violations (Parker et al., 1998), speeding (Parker, Manstead, Stradling, Reason, & Baxter, 1992; Åberg, 1999), drinking and driving (Parker et al., 1992), close following (Parker et al., 1992), dangerous overtaking (Parker, Manstead, & Stradling, 1995; Parker et al., 1992); and cutting in and reckless weaving (Parker, Manstead, et al., 1995).

The predictive power of the TPB increases when all model variables are measured at the same level of specificity. In this study, we focus on speeding, because this is one of the most common violations in traffic (e.g., Blockey & Hartley, 1995; Gras et al., 2006; Lawton, Parker, et al., 1997; Mesken et al., 2002; Parker, Reason, et al., 1995; Parker et al., 1998; Reason et al., 1990; Åberg & Rimmö, 1998); we expect that moped riders often not comply with speed limitations as well. Although mopeds are usually equipped with devices to prevent them from going faster than the speed limit, many mopeds are able to ride much faster because these devices are often adapted or removed. We will examine to what extent attitudes, subjective norm, and perceived behaviour control are able to explain the variance in intentions to speed and self-reported speeding. We hypothesise that moped riders are more likely to speed, and have a higher intention to disobey speed limits when they have a positive attitude towards speeding, when they think that others expect them to speed, and when they experience little control over their travel speed (Hypothesis 3). As we measured intention and (past) behaviour at the same time (as is often the case in single questionnaire studies), we examined relationships between TPB variables and either intentions or (self-reported) behaviour, and not relationships between intentions and behaviour; after all, it makes no sense to predict past behaviour based on future intentions.

2. Method

2.1. Respondents and procedure

In 2005, 400 young moped riders (aged 16–25) who were a client of Univé Insurances received a letter requesting their participation in a study on moped riding. In total 195 moped riders returned the reply card and received the questionnaire. Of these, 146 returned a completed questionnaire in time (net response 37%). They received a €7.50 cinema voucher. About 40% of the participants were male and 60% female, age ranged from 16 to 24 years ($M = 17.3$, $SD = 1.3$). On average, respondents drove their moped for about 18 months ($SD = 12$ months), and drove about 107 km per week ($SD = 76$).

Table 1

Confirmatory factor analysis: corrected correlations between MRQ items and error, lapses, and violations components via multiple group method. The last column shows mean scores and standard deviations of each item.

Item	Errors	Lapses	Violations	<i>M (SD)</i>
E1. Fail to notice a pedestrian crossing when turning into a side-street from a main road	.57	.29	.27	.7 (.80)
E2. Turn left on the main road into the path of an oncoming vehicle whose speed you had misjudged; as a result, the oncoming vehicle is forced to brake	.56	.35	.30	.4 (.64)
E3. Misjudge the road surface, through which your braking path is longer than you expected	.55	.31	.22	.8 (.88)
E4. Cut the bends and occasionally drive in the left lane in rural areas even though your sight is short	.55	.29	.37	1.0 (1.29)
E5. Almost go off the road because you ride too fast when turning a corner	.55	.39	.56	.8 (1.20)
E6. Fail to realise that you should give priority and narrowly avoid colliding	.51	.36	.28	.7 (.89)
E7. On turning right, nearly hit a cyclist who has come up on your inside	.50	.24	.25	.3 (.60)
E8. Underestimate the speed of an oncoming vehicle when overtaking	.43	.24	.33	.7 (.89)
E9. Misjudge your speed when approaching a crossing or traffic light and have to slam on the brakes	.43	.24	.27	.7 (.84)
E10. Brake too quickly on a slippery road and/or steer the wrong way into a skid	.38	.25	.19	1.2 (1.02)
E11. Fail to watch over your shoulder or to check your mirror before driving away or overtaking	.38	.55	.35	1.3 (1.35)
E12. Attempt to overtake a person that you hadn't noticed to be signalling its intention to turn left	.37	.30	.41	.4 (.72)
E13. Not take account of the blind spot of a car or truck	.19	.31	.05	1.3 (1.6)
L1. Misread the signs correctly, and exit from a roundabout on the wrong road	.20	.61	.18	.6 (.86)
L2. Not notice a traffic sign telling you that the road is temporarily closed	.19	.54	.24	.6 (.92)
L3. Not switch on the lights when it is dark	.21	.50	.19	.3 (.76)
L4. Not notice that the light that allows you to turn off is green	.25	.48	.05	.5 (.90)
L5. Not notice that you should ride on the carriageway rather than on the cycle lane	.27	.47	.33	1.3 (1.2)
L6. Not notice that the light turns green	.25	.46	.10	.6 (.86)
L7. Realise that you have no clear recollection of the road along which you have just been travelling	.35	.45	.41	1.0 (1.20)
L8. Forget that your lights are on full beam while you enter a well-lit area	.23	.41	.30	.8 (1.0)
L9. Intending to ride to destination A, you 'wake up' to find yourself en route to B, where the latter is the more usual journey	.28	.34	.22	.9 (1.09)
L10. Forget where you parked your moped	-.00	.33	.19	.3 (.87)
L11. Get into the wrong lane approaching a crossing	.51	.32	.27	.7 (.80)
V1. Deliberately drive too fast in build-up areas to overtake	.39	.33	.68	1.5 (1.51)
V2. Deliberately drive too fast in build-up areas when little traffic	.29	.31	.65	2.7 (1.70)
V3. Deliberately drive too fast in build-up areas to follow the traffic	.30	.20	.58	2.9 (1.61)
V4. Deliberately drive close to someone in front of you	.47	.26	.57	.64 (.86)
V5. Ride on the sidewalk in build-up areas to avoid a long way round	.45	.52	.56	1.1 (1.37)
V6. Cross an intersection knowing that the traffic lights have already turned against you	.27	.40	.54	1.2 (1.33)
V7. Drive especially close to someone in front as a signal for that driver to go faster or get out of your way	.49	.35	.53	.7 (1.08)
V8. Deliberately drive a one-way street the wrong way down	.44	.34	.51	.6 (1.00)
V9. Deliberately disregard the speed limits outside build-up areas when there is little traffic	.04	.11	.50	3.0 (1.80)
V10. Overtake a car or moped that reduces speed because you approach an area with lower speed limits	.24	.20	.50	1.0 (1.19)
V11. Accelerate when approaching a traffic light at a green/yellow phase	.30	.41	.48	1.8 (1.43)
V12. Riding your moped when you know you have drunk more alcohol than legally allowed	.37	.24	.47	.4 (.87)
V13. Get involved in unofficial 'races' with other drivers	.38	.33	.46	.6 (1.0)
V14. Riding your moped when you suppose you have drunk more alcohol than legally allowed	.26	.16	.46	.4 (.87)
V15. Ride on on a crossing while you notice that someone coming from the right has priority	.48	.29	.46	.9 (.94)
V16. Ride on on a crossing while you see that a cyclists comes from the right and has priority	.45	.33	.35	.8 (.94)
V17. Angered by another driver's behaviour, you give chase with the intention of giving him/her a piece of your mind	.16	.25	.33	.3 (.72)
V18. Deliberately turn onto a main road just in front of an oncoming vehicle although no other traffic is approaching	.46	.33	.31	.4 (.80)
V19. Not wearing a safety helmet when riding short distances	.23	.20	.30	.7 (1.22)

Note: E: error item, L: lapse item, V: violation item. For each item, the highest correlation is printed in bold. The correlations between items included in a scale and the specific scale itself were corrected for 'self correlations', i.e., in this case, corrected-item total correlations are printed. Means of the five most common aberrant behaviours are printed in italics.

2.2. Measures

2.2.1. Moped Rider Behaviour Questionnaire (MRQ)

We developed the MRQ on the basis of the Dutch DBQ (Verschuur, 2003) and personal interviews with four moped riders in the North of the Netherlands². The interviews revealed aberrant behaviours that are specific for young moped

² We asked the moped riders which types of lapses, errors, and violations they usually make, and why they violate traffic rules and norms.

riders from their own point of view; these were included in the MRQ (e.g., Not take account of the blind spot of a car or truck; Not notice that you should ride on the carriageway rather than on the cycle lane; Ride on the sidewalk in build-up areas to avoid a long way round; Not wearing a safety helmet when riding short distances). As the original DBQ focused on car users, we rephrased some items from the Dutch DBQ as to make them relevant to moped riders (e.g., replace 'car' by 'moped' (L10), including watching over your shoulder besides checking the mirror (E11); see Table 1). Also, items that were not relevant to moped riders were omitted (e.g., forget which gear you are currently in and have to check with your hand). In total, 43 items were included in the MRQ (see Table 1). Subjects were asked to indicate on a six-point scale how often they engaged in the behaviour described in each of the 43 items (0 = never, 1 = hardly ever, 2 = sometimes, 3 = regularly, 4 = often, 5 = almost always).

2.2.2. Accident involvement

Respondents indicated how many of the following accidents they had with their moped in the past year: (1) you or another person did not give right of way, (2) overtaking, (3) rear-end collision, (4) one-sided collision (no other person involved except the respondent), (5) collision with an oncoming vehicle, (6) you or another person turned off, and (7) other type of accident. The majority (59%) of the accidents involved a one-sided collision, 13% was caused by not giving right of way, 9% by road users turning off, 8% by a collision with an oncoming vehicle, 5% by a rear-end collision, and 2% by overtaking. The mean number of accidents in the preceding year was .64. The total number of accidents ranged from 0 to 4; 51% had no accident, 34% had one accidents, 11% had two accidents, 2% had three accidents, and 1% had four accidents in the year preceding the study. So, the distribution of accidents was positively skewed: half of the respondents had been involved in a traffic accident in the previous year, reflecting that moped riders are a high risk group indeed. Various types of transformations of the data did not solve this problem. Therefore, accident involvement was dichotomised (0 = no accident, 1 = one or more accident).

2.2.3. Speeding

Speeding violations were measured by the following five MRQ items: deliberately drive too fast in build-up areas to overtake; deliberately drive too fast in build-up areas when little traffic; deliberately drive too fast in build-up areas to come along with the traffic flow; deliberately disregard the speed limits outside build-up areas when there is little traffic; and get involved in unofficial 'races' with other drivers. We computed the means score on these five items ($M = 2.1$, $SD = 1.18$, $\alpha = .82$): the higher the score, the more often respondents' exceed speed limits. Besides, respondents indicated how fast they usually ride on roads with a speed limit of 30 km/h, and on roads outside built-up areas (where the speed limit is 40 km/h). Also, they indicated how many tickets for speeding they received in the past year.

2.2.4. Intention to speed

Intention to speed was measured by the following three items: I intend not to speed on my moped in the near future – recoded; I will try not to violate the speed limits in the near future – recoded; It is likely that I will frequently speed when riding my moped. The scale ranged from 1 'totally disagree' to 7 'totally agree'. We computed the means score on these three items ($M = 4.1$, $SD = 1.79$, $\alpha = .88$): the higher the score, the stronger respondents' intention to speed.

2.2.5. Attitude towards speeding

Respondents indicated to what extent they find speeding negative or positive, bad or good, not fun or fun, and not pleasurable or pleasurable. Seven point semantic differential scales were used. We computed the means score on these four items ($M = 4.5$, $SD = 1.40$, $\alpha = .90$): the higher the score, the more positive one's attitude towards speeding.

2.2.6. Subjective norm towards speeding

According to Cialdini, Kallgren, and Reno (1991), behaviour is influenced by injunctive norms, that is, the perceived opinion of others, as well as descriptive norms, that is, the perceived behaviour of others. Therefore, subjective norm was measured by means of four items, of which two reflected injunctive norms (I think that most people that are important to me do not mind that I speed on my moped; I think that people that are important to me do not approve that I speed – recoded) and two reflected descriptive norms (Most people that are important to me drive too fast; People that are important to me hardly speed – recoded). The scale ranged from 1 'totally disagree' to 7 'totally agree'. Mean scores were computed ($M = 4.6$, $SD = 1.30$, $\alpha = .67$): the higher the score, the stronger the norm in favour of speeding.

2.2.7. Perceived control over speeding

Perceived control over speeding was measured by the following four items: It is mostly up to me whether or not I speed when riding my moped; If I wanted to, I do not need to speed when riding my moped; I have control over whether or not I speed when riding my moped; It would be impossible for me to never drive too fast when I ride my moped – recoded). Again, the scale ranged from 1 'totally disagree' to 7 'totally agree'. The reliability of this scale was very low ($\alpha = .27$). Omitting items did not resolve this problem. Therefore, we used the item 'It is mostly up to me whether or not I speed when riding my moped' as an indicator of perceived behaviour control, as this item most clearly reflects the meaning of this construct. The mean score on this item was 5.8 ($SD = 1.55$).

3. Results

3.1. Errors, lapses and violations

A confirmatory factor analysis (CFA) was conducted to test whether a distinction could be made between errors, lapses, and violations of moped riders³. We used the multiple group method (MGM), a simple and effective type of confirmatory factor analysis (e.g., Nunnally, 1978; Nunnally & Bernstein, 1994) to verify whether the data supported the groupings of aspects into error, lapses, and violations. In the MGM, we first defined components (i.e., errors, lapses, and violations scales) on theoretical grounds. For this purpose, we computed the mean score on MRQ items supposedly related to each of the three scales. Next, correlations were computed between MRQ items and the three components. For items included in a scale, the correlation coefficients were corrected for 'self-correlation', that is, the fact that items automatically correlate high with components in which they take part. Finally, we verified whether the MRQ items indeed correlated highest with the component (that is, scale) to which they are assigned on theoretical grounds. The factor structure (that is, the grouping of MRQ items into the scales) is supported when items correlate highest with the component they are assigned to on theoretical grounds (see Nunnally, 1978; Nunnally & Bernstein, 1994).

The corrected correlations given in Table 1 show that the majority of MRQ items correlated strongest with the component with which it was associated in theory, thus providing empirical support for the assignment made on theoretical grounds. The three factors explained 34% of the variance. There are some exceptions, however. Two items supposed to measure errors (Almost go off the road because you ride too fast when turning a corner; Attempt to overtake a person that you hadn't noticed to be signalling its intention to turn left) correlated most strongly with the violations factor. Another two items supposed to measure errors (Not take account of the blind spot of a car or truck; Fail to watch over your shoulder or to check your mirror before driving away or overtaking) correlated most strongly with the lapses factor, while an item supposed to reflect a lapse (Get into the wrong lane approaching a crossing) correlated most strongly with the errors factor. Furthermore, three items believed to measure violations (Ride on on a crossing while you see that a cyclist comes from the right and has priority; Ride on on a crossing while you notice that someone coming from the right has priority; Deliberately turn onto a main road just in front of an oncoming vehicle although no other traffic is approaching) correlated most strongly with the errors factor. These eight items were omitted from further analyses.

Some items did not differentiate strongly (e.g., Almost go off the road because you ride too fast when turning a corner; Realise that you have no clear recollection of the road along which you have just been travelling; Drive especially close to someone in front as a signal for that driver to go faster or get out of your way), but did correlate most strongly with the factor they were assigned to on theoretical grounds. Therefore, these items were included in further analyses.

Scores on errors, lapses, and violations were computed on the basis of the remaining 35 items by computing the average scores on the relevant items. The internal consistency of the resulting scales was good (errors: $\alpha = .80$; lapses $\alpha = .79$; violations: $\alpha = .87$). Violations were more common ($M = 1.2$; $SD = .72$) than were errors ($M = .7$; $SD = .55$) and lapses ($M = .7$; $SD = .57$). Errors and lapses were both positively skewed. Therefore, we computed the logarithm of the scores on errors and lapses; these were included in the relevant analyses. The three types of aberrant behaviour were relatively strongly correlated; the correlation between errors and lapses was .46, the correlation between errors and violations .40, and the correlation between lapses and violations was .39.

3.1.1. Speeding

Speeding was quite common among our sample. Table 1 shows that 4 out of 5 most common violations were speeding offences. Moreover, respondents drove on average 41 km/h ($SD = 10.38$) on roads with a speed limit of 30 km/h, while the mean kilometrage on roads outside built-up areas (where the speed limit is 40 km/h) was 56 km/h ($SD = 11.87$). They hardly received any tickets for speeding in the past year ($M = .06$, $SD = .32$).

3.1.2. Predicting speeding

Attitudes towards speeding, subjective norms towards speeding, and perceived control over speeding explained 43% of the variance in self-reported speeding violations: $F(3, 139) = 35.51$; $p < .001$. Respondents were more likely to speed when they had a positive attitude towards speeding ($\beta = .48$; $t = 6.70$, $p < .001$) and when the subjective norm was in favour of speeding ($\beta = .23$; $t = 3.14$, $p = .002$). Perceived behaviour control did not contribute to this model when attitudes and norms were controlled for.

3.1.3. Predicting intention to speed

Attitudes, subjective norms, and perceived behaviour control explained 54% of the variance in intention to speed: $F(3, 138) = 54.88$; $p < .001$. Both attitudes ($\beta = .49$; $t = 7.52$, $p < .001$) and subjective norm ($\beta = .35$; $t = 5.24$, $p < .001$) contributed significantly to the model: respondents had a stronger intention to speed when they had a positive attitude towards

³ In contrast to an exploratory factor analysis (PCA) in which the a priori assumption is that any indicator may be associated with any factor, a confirmatory factor analysis seeks to determine if the number of factors and the loadings of measured (indicator) variables on them conform to what is expected on the basis of pre-established theory. As we have a clear theory of which types of aberrant behaviours can be distinguished for moped riders, we examined if the variables correlate as predicted with the expected number of factors.

speeding and a subjective norm in favour of speeding. Again, perceived control over speeding was not significantly related to intention to speed when attitudes and subjective norm were controlled for.

3.1.4. Predicting accident involvement

As we asked respondents about the number of accidents they had in the last year, only respondents that drove their moped for 12 months or more were included in the analysis ($N = 97$). About 49% of these respondents had no accident in the previous year. A logistic regression revealed that errors, lapses, and violations did not significantly predict accident involvement: Nagelkerke's $R^2 = .05$; $\chi^2 = 3.50$, $df = 3$, $p = .320$; $-2 \text{ Log Likelihood} = 116.170$. When including sex, age, number of months respondents had their moped, and weekly mileage in the logistic regression analysis as well, the model was still not significant (Nagelkerke's $R^2 = .07$; $\chi^2 = 4.36$, $df = 7$, $p = .737$; $-2 \text{ Log Likelihood} = 113.693$).

4. Discussion

Moped riders are a high risk group in traffic, but surprisingly little research has been conducted on factors influencing crash involvement of moped riders, and on ways to reduce the high risks. We aimed to examine the dimensions underlying aberrant behaviour of moped riders, which aberrant behaviours cause accidents of moped riders, and which factors influence speeding violations of moped riders.

The first aim of this study was to examine whether aberrant behaviours of moped riders can be categorised into errors, lapses, and violations, like aberrant behaviour of car drivers. Our results largely validated the hypothesised distinction between errors, lapses and violations. The three factors explained 34% of the variance, which is comparable to earlier studies that examined aberrant behaviours of car users (e.g., Kontogiannis et al., 2002; Mesken et al., 2002; Reason et al., 1990; Sullman et al., 2002; Åberg & Rimmö, 1998). However, two items supposed to measure errors correlated most strongly with the violations factor, while three items supposed to measure violations correlated most strongly with the errors factor. Two error items were most strongly related to the lapses factor, while one lapse item most strongly correlated with the errors factor. Also, some items correlated strongly with multiple factors and thus did not differentiate strongly. This agrees with results of earlier studies (e.g., Bener et al., 2008; Davey et al., 2007; Lajunen, Parker, & Summala, 2004). Probably, respondents were not sure whether some of the behaviour reflected deliberate actions or not. Blockey and Hartley (1995) also found that some unintentional violations items loaded most strongly with a so-called 'general errors' factor. Like our study, Blockey and Hartley (1995) interviewed a relatively young sample: 72% of their respondents were 26 years or younger, while our respondents were all younger than 25. Also, both studies included a relatively high proportion of females. This suggests that future studies, at least studies among young (female) respondents, should include items that clearly indicate whether the behaviours are intentional or unintentional, to avoid ambiguity about the purposiveness of the actions (see also Lajunen et al., 2004). More generally, scholars should carefully consider the phrasing of the relevant items to clearly differentiate errors, lapses, and violations.

Not surprisingly, errors, lapses and violations were correlated. This agrees with studies among private and professional drivers (Davey et al., 2007; Dobson et al., 1999; Gras et al., 2006; Lajunen et al., 2004; Özkan & Lajunen, 2005). This again illustrates that the three different types of aberrant behaviour are not independent. Whether a particular behaviour classifies as an error, lapse, or violation may depend on specific personal, social, cultural, and situational circumstances (see also Davey et al., 2007; Lajunen et al., 2004; Özkan et al., 2006) as well as on the exact wording of the particular behavioural item. This is an important topic for future research (see also Gras et al., 2006; Lajunen et al., 2004).

Speeding violations were the most common aberrant behaviour among moped riders. This is in line with research among car drivers (e.g., Kontogiannis et al., 2002; Parker, West, et al., 1995; Reason et al., 1990). Moped riders participating in this study were more likely to speed when they had a positive attitude towards speeding, and when the subjective norm was in favour of speeding. Perceived behaviour control did not predict speeding when attitudes and subjective norms were controlled for. Attitudes, subjective norm, and perceived behaviour control predicted a substantial proportion of the variance in speeding, indicating that the theory of planned behaviour is successful in predicting speeding. A similar pattern of results was found when explaining intention to speed in the near future: respondents had a stronger intention to speed when they had a positive attitude towards speeding, and when they perceived a subjective norm in favour of speeding. The TPB explained 54% of the variance in intention to speed, again indicating that this model is predictive of speeding violations. Attitudes, subjective norms, and perceived behaviour control were more successful in predicting intentions than self-reported behaviour, which is in line with the TPB. These results support our third hypothesis and corroborate results of previous studies among car drivers that examined the extent to which the TPB variables predict speeding offences (Parker et al., 1992).

Almost half of the sample had been involved in an accident in the year preceding the study, indicating that moped riders are a high risk group indeed. The accident involvement is substantially higher than accident involvement of motorcyclists and car users (e.g., Rimmö & Åberg, 1999; Davey et al., 2007; Dobson et al., 1999; Elliot et al., 2007; Gras et al., 2006; Kontogiannis et al., 2002; Parker, West, et al., 1995; Parker et al., 2000; Sullman et al., 2002), confirming our assumption that young moped riders are a high risk group in traffic. Errors, lapses and violations did not significantly contribute to the explanation of accident involvement in the past year. Overall, only a small, non-significant, percentage in accident involvement was explained by errors, lapses, and violations. This implies that our second hypothesis is not supported. Even though violations, and particularly speeding violations, are common among young moped riders, they do not predict accidents.

Previous studies also revealed that typically a rather small (although significant) proportion of the variance in crash involvement is explained, mainly by violations (Parker, Reason, et al., 1995; Sullman et al., 2002). However, these studies typically are based on large samples, which makes it easier to detect significant (but small) effects. In our study, the regression analysis was based on only 97 respondents who did ride their moped for more than 12 months, which was probably not sufficient to detect small effects (although about half of them had been involved in an accident in the year preceding the study). In general, the three types of aberrant driving behaviour do explain a small percentage of the variance in accident involvement of different groups of road users only (e.g., Gras et al., 2006; Kontogiannis et al., 2002; Parker, Reason, et al., 1995; Özkan et al., 2006), suggesting that various other factors play a role in crash involvement, such as situational factors. Another explanation for the non-significant results is that we relied on self-reported behaviour. Young moped riders may not be fully aware of the errors, lapses, and violations they make, and may not provide accurate assessments of their aberrant behaviour.

This study was one of the first attempts to examine aberrant behaviour of moped riders and factors influencing speeding offences of moped riders. Our sample included young moped riders. Future studies are needed to test the robustness of our findings in other groups (including other age groups), countries, and cultures. A possible limitation of our study is that we relied on self-reported accident involvement, and self-reported behaviour. Moped riders may not correctly remember how often they were involved in traffic accidents, or they may not record all accidents to present a positive self image. The same may be true for errors, lapses, violations, and more specifically, speeding offences. A possible underreporting of accident involvement will most likely lead to underestimating true relationships in a population, because lower variations in scores would result in range restrictions (cf. Parker, West, et al., 1995, see above). Self-reports do have important advantages: Anonymous surveys provide in-depth information about aberrant behaviour as well as the motivational factors related to this behaviour (see Lajunen et al., 2004).

Another limitation of this study is that we used a one item measure of perceived behaviour control in the analyses, because we were not able to compose a reliable multi-item scale based on the four items supposed to measure perceived behaviour control. This agrees with studies by Parker et al. (1992, 1998; Parker, Manstead, et al., 1995), who also reported very low alpha reliabilities for perceived behaviour control. This is surprising, because studies that tested the theory of planned behaviour in other domains generally did report reliable measures of perceived behaviour control. Maybe the perceived control measure needs to be adapted when applied to traffic violations. This is an important topic for future research.

Based on this study, several policy recommendations can be given. Our results suggest that policies should target violations, and particularly speeding violations, as these are very common among moped riders. Moped riders' commission of speeding violations may best be reduced by changing attitudes and subjective norms related to speeding. The moped riders in our sample had reasonable positive attitudes and norms towards speeding; scores on both constructs were above the mid-point of the scale. Moped riders have to learn why particular behaviours are important, which behaviours cause serious accident risks, and the likely consequences of unsafe riding (cf. Rutter & Quine, 1996). Moreover, they can be informed about the expectations of others, and more specifically, the extent to which others disapprove of speeding. Furthermore, stricter enforcement of speed limits is warranted so as to increase the objective and subjective probability of detection (see also Groeger & Rothengatter, 1998; Lawton, Parker, Stradling, et al., 1997). Our results clearly reveal that speeding offences are very common among moped riders, but they are hardly fined for these offences. Changing attitudes and subjective norms will probably require much time and effort, including information campaigns, education, and higher-profile enforcement of relevant traffic rules (cf. Parker, Reason, et al., 1995). Recent campaigns on drink-driving in various countries (e.g., UK, The Netherlands) show that such attempts may be very successful; our results show that drink-driving is indeed not common among young moped riders; in fact, drink-driving appears to be among the least common aberrant behaviours of moped riders. Future studies could systematically test the effects of various strategies to reduce speeding offences of moped riders.

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