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The Dula Dangerous Driving Index: An Investigation of Reliability and Validity across Cultures

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Abstract

The aim of this study is to further establish the validity and reliability of the Dula Dangerous Driving Index (DDDI). The reliability and validity of the instrument was investigated by comparing data from a US university sample, a US community sample, and a sample of Belgian traffic offenders. Exploratory and confirmatory factor analysis supported the presence of a four-factor structure with items for Drunk Driving forming a separate scale apart from items for Risky Driving, Negative Cognitive/Emotional Driving and Aggressive Driving. A multi-group confirmatory factor analysis with model constraints supported the validity of the DDDI. Inter-correlations revealed that the DDDI subscales are closely interrelated and uni-dimensionality of the measure was found in all three samples. This suggests the DDDI Total score can be used as a composite measure for dangerous driving. However, the validity of the subscales was demonstrated in the Belgian sample, as specific traffic offender groups (convicted for drunk driving, aggressive driving, speeding) scored higher on corresponding scales (Drunk Driving, Aggressive Driving, and Risky Driving, respectively), indicating that it is clinically meaningful to differentiate the subscales.

Numerous studies have documented that aggressive driving is indeed a real problem (e.g., Canada Safety Council, 2001; Joint, 1995; Lajunen & Parker, 2001; Mizell, 1997; Sarkar et al., 2000; Rathbone & Huckabee, 1999; U.S. Department of Transportation, USDOT, 1998), though how much damage is done and whether or not it is increasing is a matter of debate (e.g., James & Nahl, 2000; Martinez, 1997; Sullman et al., 2007; USDOT, 1998). However, it seems aggressive driving is a construct that remains unclear in much of the literature. The following serves to elucidate the issue and provide the rationale for the division of the breadth of coverage in the Dula Dangerous Driving Index (DDDI) and its division into distinct subscales.

A critical feature of interpersonal aggression is intent to harm, either psychologically (as with insults or gestures) or physically (e.g., Baron & Richardson, 1994; Geen & O'Neil, 1976; Goldstein, 1994; Felson, 2000). When applied to a vehicular context, intention is often implied but usually not truly known. A variety of aggressive driving definitions have been posited (e.g., Connell & Joint, 1996; Joint, 1995; Ellison-Potter, Bell, & Deffenbacher, 2001; Gulian, Matthews, Glendon, & Davies, 1989; James & Nahl, 2000; Mizell, 1997; Sarkar et al., 2000; Shinar, 1998); however, a common factor is that all include behaviors and cognitive and/or emotional states that make the driving situation more dangerous. Dula and Geller (2004) highlighted problems with defining driver aggression and posited that it is more useful to construe aggression as but one facet of dangerous driving. Dangerous driving encompasses

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aggression with intent to harm, negative emotions and cognitions such as anger, frustration, and rumination (all of which can be had without exhibiting aggression but which nonetheless tax attention better spent on driving tasks), as well as risky driving behaviors which are often considered as aggressive, but which lack actual intent to harm.

Reasons abound for researching dangerous driving constructs beyond aggression, which of course, is also necessary to study. Sullman and colleagues (2007) documented an increase in driving anger research, noting that while evidence for an actual increase in driving anger is inconclusive, studying driving anger is important because it is common and angry drivers engage in more dangerous behaviours including losing vehicular control, near hits, losing concentration, and crashing in simulators. While not necessarily leading to actual aggressive behavior, anger, irritation, frustration, and related rumination, may well increase one's risk of becoming involved in a crash, and are thus dangerous in and of themselves (Sullman et al., 2007).

Another dangerous driving issue apart from aggression per se is that of risk-taking. Most that perform risky behaviors while driving do not intend to cause harm to others, and are not necessarily experiencing negative cognitions/emotions. Risky behaviors are also common. These drivers likely believe themselves to be capable of navigating risks or do not give sufficient weight to the potential for devastating consequences. Again, purely risky driving actions are not aggressive as there is no intent to harm.

Thus, as follows from above, three major dangerous driving categories are measured by the DDDI: a) intentional acts of aggression, b) negative cognitive/emotional experiences, and c) risk-taking (Dula & Ballard, 2003; Dula & Geller, 2004). Any of these might easily be further divided to refer to more specific driving actions, such as the potential in the DDDI for the risky driving construct to contain an intoxicated driving construct. Likewise, in the case of highly aggressive driving, all three constructs are likely present simultaneously, with anger, aggression, and risky driving co-occurring.

Various aspects of dangerous driving are of empirical and practical concern and there are individual differences to be explored. Sound measures of dangerous driving are needed to understand differences and commonalities between aggression, negative cognitive/emotional driving, and risky driving. The Dula Dangerous Driving Index (DDDI) is one of several published measures and others include the Driving Anger Expression Inventory (DAX, Deffenbacher, Lynch, Oetting, & Swaim, 2002), the Driving Anger Scale (Deffenbacher, Oetting, & Lynch, 1994), the Driver's Angry Thoughts Questionnaire (DATQ, Deffenbacher, Petrilli, Lynch, Oetting, & Swaim, 2003), and the Propensity for Angry Driving Scale (PADS, DePasquale, Geller, Clarke, & Littleton, 2001). These latter surveys focus on measurement of anger. The DDDI on the other hand measures drivers' likelihood to drive dangerously, consistent with the aggressive driving, negative cognitive/emotional driving, and risky driving subcategories mentioned.

The DAX, DATQ, and the PADS have been the subject of recent empirical scrutiny (e.g., Dahlen & Ragan, 2004; Deffenbacher, White, & Lynch, 2004), where they have been found to be relatively valid and useful measures. Similarly, this work serves to elaborate on the initial reliability and validation work done on the DDDI (Dula & Ballard, 2003; Dula, 2003). The DDDI has shown utility in predicting self-reported at-fault crashes, moving violations, and a variety of risky, negative emotional, and aggressive driving experiences (Dula, 2003; Dula & Ballard, 2003), but had not been used in community or clinical samples (i.e., those identified by law enforcement as offenders). This report addresses psychometric properties of the DDDI using data gathered in a clinical sample in Belgium and university and community samples in the US, adding an important cross-cultural facet to the analyses.

Method

Participants

Three samples participated in separate projects and have been analyzed separately in this report: a Belgian traffic offenders group, a US university student group, and a US community group. The Belgian sample consisted of 255 drivers who were court mandated to participate in a Driver Improvement program at the Belgian Institute for Road Safety (BIVV). They were convicted of different sorts of traffic offences, such as driving under the influence (DUI), traffic aggression, speeding, driving without legal papers, etc. This sample was almost exclusively male (only 4% female) and aged between 17 and 78 (mean = 31.1; SD = 12.2). Ninety-five percent of this sample was Caucasian while the remaining 5% consisted mostly of north Africans. The DDDI was completed in small groups of 8 to 10 respondents under the supervision of BIVV personnel at the beginning of the Driver Improvement program.

The US university sample was part of a larger study (Dula, 2003) on personality and driving and consisted of 274 students, aged between 17 and 46 (mean = 19.4; SD = 2.6), 41% of whom were male. Seventy-six percent were Caucasian, 10% were African-American and 7% were Asian. Students received modest extra credit in psychology classes for filling out counter-balanced packets of surveys in small to medium-sized groups of no more than 30 per sitting. Findings presented here were not presented in Dula (2003).

The US community sample consisted of 192 subjects aged between 17 and 79 year (mean = 36.8; SD = 14.6). Fifty-three percent were female. The majority of this sample was Caucasian (90%) while 6% were African American. Participants completed the DDDI in small to medium-sized groups numbering no more than 30 per sitting as part of a National Institutes of Health funded intervention designed to reduce negative emotional driving and increase pro-social driving. Drivers were recruited via flyers in businesses, newspaper and radio advertisements, and in-person at large retail stores. They were randomly assigned to experimental groups based on availability for initial sessions. Each group was given driving diaries to tally driving experiences and directions pertinent to their group (all learned a Code to communicate with others via hazard lights or light affixed to the rear windshield) and then filled out the surveys. Factor analytic data are from the pre-intervention phase when no manipulations had occurred beyond describing the experimental conditions. There were no differences in DDDI amongst the groups from this initial session. Participants received \$5 (US) for their involvement.

US community test-retest data comes from post-intervention focus groups at the end of a 10-week study period. Attrition yielded a total of only 108 drivers taking the DDDI at post-test in small groups of no more than 10 participants. Ages ranged from 17 to 71 (mean = 41.0, SD = 13.7), 59% were female, 90% were Caucasian and 6% African-American. There were no significant differences in DDDI scores among the groups at post-test and participants received \$45 leaving the post-intervention focus groups.

Measures

Dula Dangerous Driving Index (DDDI)—The following summarizes the original development of the DDDI, a full account of which is in Dula and Ballard (2003). DDDI items with subscale labelling are presented in Appendix A. The measure was created based on what was, at the time, commonly referred to as aggressive driving in the literature (e.g., Connell & Joint, 1996; James, 1997; Joint, 1995; Larson, 1997; Martinez, 1997; Mizell, 1997; Snyder, 1997; USDOT, 1998). Following pilot testing, the measure was honed to 28 items, and based on expert feedback, items were split into three conceptually distinct subscales: Risky Driving (12 items, $\alpha = .83$), Negative Cognitive/Emotional Driving (9 items, $\alpha = .85$; first referred to

as Negative Emotional, Cognitive is now added to the subscale's label for a more accurate description as emotions and cognitions co-occur), and, Aggressive Driving (7 items, $\alpha = .84$).

A principle components factor analysis was performed on all items, and suggested a unitary dangerous driving factor (Dula, 2003). The DDDI conceptual subscales were also subjected to principle components factor analyses, where Negative Cognitive/Emotional Driving and Aggressive Driving subscales yielded single factor solutions with all items loading at .47 or higher or .63 or higher, respectively (Dula, 2003). This was similar for the Risky Driving subscale with all items loading at .41 or higher, except for the emergence of a separate two-item factor tapping intoxicated driving. These two items, and no others, loaded highly on a factor which accounted for 5% of the variance. The DDDI showed good internal reliability with total scale and subscale alpha coefficients ranging from .83 to .92 (Dula & Ballard, 2003), and evidence for concurrent, divergent, and predictive validity was demonstrated (Dula, 2003, Dula & Ballard, 2003).

For the Belgian sample, the DDDI was translated into Dutch following the translation/back-translation procedure of Brislin (1980) (¹). Since initial analysis in the Belgian sample revealed that the items for drunk driving form a separate factor (which can also be traced in previous studies in US samples [Dula, 2003]), the above mentioned three factor model consisting of Risky Driving, Negative Cognitive/Emotional Driving and Aggressive Driving will be compared with a four-factor model adding the scale Drunk Driving.

Social Desirability—In the sample of Belgian traffic offenders, a short five-item version of the social desirability measure of Crowne-Marlowe was used. This measure was translated into Dutch and used in questionnaires on antisocial behavior, e.g., BDHI aggression questionnaire (Lange et al., 1995). The five items were scored on a five-point Likert scale. Higher scores indicate the tendency to give answers concordant with conventional norms, and to avoid discordant answers. The internal consistency of this scale in the current sample of Belgian traffic offenders is moderately low ($\alpha = 0.63$).

Results

Distribution, Consistency and Uni-dimensionality of Scales—Table 1 presents measures of consistency computed separately in the three samples. These measures include Cronbach's Alpha, and the mean item intercorrelation $r(ii)$. There were only small differences in indices of consistency between the Belgian, US university, and US community samples. The Cronbach alpha's ranged from 0.67 to 0.93. This means that some of the subscales do not meet the criterion of $\alpha \geq 0.80$ for a new scale (Clark & Watson, 1995), where the Drunk Driving subscale is most problematic in this respect. However, Clark and Watson (1995) pointed out that Cronbach alpha is an ambiguous indicator of internal consistency because it depends on two parameters: number of items in a scale and mean item intercorrelation. As the Drunk Driving subscale consists of only two items, this may bring down the alpha. The mean item intercorrelation on the other hand is a straightforward indicator of internal consistency that is independent from the number of items. The mean item intercorrelation $r(ii)$ of the scales in the three samples ranged from 0.24 to 0.65. This means that all scales, including the Drunk Driving subscale, meet the criterion advocated by Clark and Watson (1995) that the average inter-item correlations fall in the range of 0.15 to 0.50.

¹Specifically, an initial translation was carried out independently by three native speakers. The three translators compared their versions and agreed upon one version. This version was back-translated by a professional English-Dutch translator. Differences between the original items and the back-translated items were evaluated by the three native speakers. Improvements were discussed and implemented.

For the US community sample test-retest correlations were available for a ten week period. All test-retest correlations were significant, corroborating response stability over time and indicate solid predispositions to maintain driving styles and attitudes.

The uni-dimensionality of the subscales was assessed by fitting a single factor model to the data of each subscale by means of a confirmatory factor analysis. The statistical program LISREL 8.7 was used. This analysis was not executed on the Drunk Driving subscale as it consists of only two items. Table 1 contains the results of the analyses of the scores in the three samples. The formal chi-square tests of the uni-dimensionality of subscales were significant in most cases, indicating that a significant proportion of the data remains unexplained by the model. However, a significant chi-square should not lead to rejection of the model as this can be an artefact of sample size and small variations in data (Hu & Bentler, 1995). Other fit indices such as the Goodness of Fit Index (GFI) and the Adjusted Goodness of Fit Index (AGFI) suggest that uni-dimensionality is tenable: the mean AGFI for the three samples equals 0.84, 0.82 and 0.78, respectively. The values of the Root Mean Square Error of Approximation (RMSEA) suggest a satisfactory fit in six cases ($RMSEA \leq 0.08$), a moderate fit in two cases ($0.08 < RMSEA \leq 0.10$), and an unsatisfactory fit in two cases ($RMSEA > 0.10$) (Browne & Cudeck, 1993).

Internal Structure of Items—Using multi-group confirmatory factor analyses, the one-factor model, the three-factor model of Dula & Ballard (2003) and Dula (2003) and the four-factor model were applied to the data. This procedure allows to compare the fit of models in several groups simultaneously. Although the one-factor model has a satisfactory fit ($RMSEA \leq 0.08$), the three- and four factor model definitely fit better. The three and four factor models were compared using the Akaike's Information Criterion (AIC) and the Consistent Akaike's Information Criterion (CAIC) to determine the parsimony of a model. As can be seen in Table 2, the values for the AIC and CAIC for the four-factor model (3) were lower than the values for the three-factor model (2). The four-factor model is preferable because it is more parsimonious in fitting the data than the three-factor model. A second argument for the eligibility of the four-factor model is given by the Modification Indices (MI). The MI are a univariate Lagrangian multiplier test that give information about the amount of χ^2 change that would result if parameters that formerly were fixed were free in a model. The MI of the three-factor model indicate that the greatest improvement in the fit of the model would be realized by setting free the error covariance between the two items for drunk driving. This means these two items have some covariance in common that cannot be explained by the factor Risky Driving. Therefore, it is recommended that these items be isolated as a separate, fourth factor.

In order to assess the cross-cultural validity of the four factor model, several models with increasing constraints were tested. The Santorra-Bentler Chi-Square Statistic indicates the best fit for the unconstrained model (3). Using the Chi-square difference test, we see the model with equal factor loadings (4) fits the data significantly worse than the unconstrained model (3). However, for this model the RMSEA was still in the range of a satisfactory fit ($RMSEA \leq 0.08$). Taking a cut-off value of 2, the values for the χ^2/df index were good. Thus, the fit of the constrained model (4) is still acceptable. The same goes for the comparison between model (5) with equal loadings and factor (co)variance and model (4) with equal loadings only. Finally, we find that the model with equal factor loadings, equal factor variance and covariance, and equal error terms (6) still has good χ^2/df and RMSEA fit indices. The chance the RMSEA is smaller than 0.05 equals 0.31. The Comparative Fit Index ($CFI = 0.98$) and the Non-Normed Fit Index ($NNFI = 0.98$) exceed the recommended value of 0.95 (Hu & Bentler, 1999).

The covariances between the factors Risky Driving, Negative Cognitive/Emotional Driving, and Aggressive Driving were quite high, which indicates that these three factors can be understood as closely related constructs (in Model (6) covariance RD-NCED = 0.76; RD-AD

= 0.87; AD-NCED = 0.82). On the other hand, the covariances between these three factors and the factor for Drunk Driving were smaller (in Model (6) covariance RD-DD = 0.44; NCED-DD = 0.37; AD-DD = 0.38).

Relation with Age, Gender, Social Desirability, and Type of Traffic Offender—In all samples, the relation between age of the respondents and their scores on the DDDI scales was examined via Pearson product-moment correlations. Adjusted R^2 statistics are also reported. We found significant negative correlations with most of the scales in the group of Belgian traffic offenders (Age-RD = -0.25 , $R^2 = 0.06$; Age-NCED = -0.24 , $R^2 = 0.05$; Age-AD = -0.32 , $R^2 = 0.10$; Age-DDDI total score = -0.25 , $R^2 = 0.06$) and a small but significant positive association for the subscale Drunk Driving (Age-DD = 0.18 , $R^2 = 0.03$). All correlations were significant at the 99% confidence interval. In the sample of US university students, no significant correlations were found. This was due to the homogeneity of age in this group, as 92% of this sample was between 18 and 21 years of age. In US community sample, all correlations were negative and significant at the 99% confidence interval (Age-RD = -0.36 , $R^2 = 0.13$; Age-NCED = -0.43 , $R^2 = 0.18$; Age-AD = -0.43 , $R^2 = 0.18$; Age-DD = -0.30 , $R^2 = 0.08$; Age-DDDI total score = -0.39 , $R^2 = 0.15$).

In the US university and community sample, scores on all scales of male and female respondents were compared via ANOVA. The number of females in the Belgian sample of traffic offenders was too small to make this comparison. In the US university and community sample respectively, males scored higher on the scales for Risky Driving ($F(1,266) = 18.62^{**}$, Partial $\eta^2 = 0.07$; $F(1,186) = 5.39^*$, Partial $\eta^2 = 0.03$), Aggressive Driving ($F(1,267) = 8.31^{**}$, Partial $\eta^2 = 0.03$; $F(1,188) = 5.75^*$, Partial $\eta^2 = 0.03$), Drunk Driving ($F(1,267) = 7.12^{**}$, Partial $\eta^2 = 0.03$; $F(1,188) = 14.38^{**}$, Partial $\eta^2 = 0.07$) and the DDDI total score ($F(1,267) = 11.58^{**}$, Partial $\eta^2 = 0.04$; $F(1,188) = 4.00^*$, Partial $\eta^2 = 0.02$). However, the difference between males and females in scores on the scale for Negative Cognitive/Emotional Driving was not significant ($F(1,267) = 1.52$, Partial $\eta^2 = 0.01$; $F(1,188) = 0.12$, Partial $\eta^2 = 0.00$), consistent with Dula and Ballard (2003) and Dula (2003), indicating that both genders are equally likely to experience negative emotions while driving.

In the Belgian sample of traffic offenders, the scale-scores on the DDDI were correlated with scores on Social Desirability (SD). Adjusted R^2 statistics were also calculated. We found negative correlations significant at the 99% confidence interval between the DDDI-scores and a tendency toward socially desirable answering (SD-RD = -0.42 , $R^2 = 0.17$; SD-NCED = -0.46 , $R^2 = 0.20$; SD-AD = -0.41 , $R^2 = 0.16$; SD-DD = -0.14 , $R^2 = 0.02$; SD-DDDI total score = -0.49 , $R^2 = 0.24$). This means that the scores on the scale for social desirability explain only 2% of the variance in the Drunk Driving subscale, but up to 24% of the variance in the DDDI total scores.

In order to examine the discriminant validity of the DDDI, three subsamples of the Belgian traffic offenders were selected based on the type of traffic offence they committed (aggressive driving, drunk driving or speeding). In order to have clear groups, offenders who committed other offences (for instance driving without legal papers) or who committed multiple types of traffic offences were left out of this analysis. A MANOVA showed that the scores on the DDDI-subscales differed in function of the traffic offender type (Wilks' $\lambda = 0.75$, $F(8, 298) = 5.80$, $p < 0.0001$). Subsequent univariate analysis revealed that the three groups differed significantly on all scales. Table 3 contains mean scores, standard deviations and F-values. The effect size was largest for Risky Driving (Partial $\eta^2 = 0.14$) and smaller for all other scales (Negative Cognitive/Emotional Driving: Partial $\eta^2 = 0.05$; Aggressive Driving: Partial $\eta^2 = 0.08$; Drunk Driving: Partial $\eta^2 = 0.07$; total DDDI-score: Partial $\eta^2 = 0.09$). Post hoc Bonferroni comparison of the three groups in Table 3 indicates that the DDDI differentiates mainly between the group of drunk drivers and the group of aggressive drivers. Drunk drivers report

the lowest level of dangerous driving, except for the scale Drunk Driving. On the other hand, the group of aggressive drivers report the highest level of dangerous driving, except for Drunk Driving. Finally, the group convicted for speeding can be situated between the two other groups.

Discussion

The aim of this study was to investigate the reliability and validity of the Dula Dangerous Driving Index (DDDI) in different types of samples and in different regions. Data gathered in both the US and Belgium permitted us to assess the reliability and validity of this measure in two cultures. The results of this study provide evidence of the psychometric soundness of the DDDI. The DDDI internal consistencies were relatively high across all samples, although the scale for Drunk Driving was somewhat weaker. Solid test-retest reliability was demonstrated for a ten week period in the US community sample, although the number of respondents at re-test was considerably reduced because of attrition.

In all three samples we found comparable indices for internal consistency and uni-dimensionality of the scales. A multi-group confirmatory factor analysis with constraints of equal factor loadings, factor (co)variance and error terms across groups, confirmed the applicability of the DDDI in different regions. This means that the factor structure of the DDDI can be replicated in different populations from different regions, such as US students, US community members, and Belgian traffic offenders.

In all samples, the four scales of the DDDI clearly showed a pattern of interrelated measures for dangerous driving. The covariances between the factors in the multi-group CFA were considerably high. Moreover, when we fitted a one factor model on the data, we obtained a satisfactory fit. Therefore, the total score on the DDDI can be used as a composite measure for dangerous driving.

However, the better fit of the four-factor model in comparison to the one-factor model suggests that the four subscales contain information that is not captured by the total score. At the same time, the validity of the different subscales was confirmed by the Belgian sample of traffic offenders. We considered the type of traffic offence committed by the respondents in the Belgian sample as a criterion for the scale scores. According to our expectation, mean scale scores appeared to differ depending on the type of traffic offence committed by the respondent. Indeed, drunk drivers scored higher mainly on the scale for Drunk Driving, while they scored lower on the other scales. Aggressive drivers scored higher on Risky Driving, Negative Cognitive/Emotional Driving, and Aggressive Driving, but not on Drunk Driving. Traffic offenders convicted for speeding had intermediate scores on all scales. These findings offer support for the theoretical relevance and the clinical utility of the division of dangerous driving into well-defined subcategories. We suggest that depending on his purpose, the user can choose to interpret subscale and/or total scores of the DDDI.

The finding that older drivers and female drivers score lower on most of the scales of the DDDI is consistent with international literature, suggesting that drivers seem to become more law abiding and less risk taking when they grow older (e.g., Golias & Karlaftis, 2002). The finding consistent with some studies, that females and males do not differ in terms of their negative emotional experiences (e.g., Dula & Ballard, 2003; Dula, 2003) or anger (e.g., Dahlen & White, 2006; Smith, Waterman, & Ward, 2006) on the road, is an important issue as anger while driving has been shown to be associated with driving risk (e.g., Dahlen, Martin, Ragan, & Kuhlman, 2005; Deffenbacher, Lynch, Oetting, & Yingling, 2001; Sullman et al., 2007; Underwood, Chapman, Wright, & Crundall, 1999). That driving is frequently a source of frustration for everyone is an empirical confirmation of an intuitive conclusion. As being in a

state of negative emotionality with its attendant cognitive rumination negatively impacts one's ability to drive safely, this is an important issue in need of more attention.

In a number of studies, anger has been shown to be higher for women, but why this is or how it differs from the negative affect measured by the DDDI calls for more study. This need for further study is echoed by the fact that the higher levels of anger found for females were not consistent across all factors or measures of anger used by researchers (e.g., Deffenbacher, Oetting, & Lynch, 1994; Lajunen, Parker, & Stradling, 1998; Parker, Lajunen, & Summala, 2002; Sullman et al., 2006). Therefore, gender differences in emotionality while driving should continue to be a focus of research.

An important finding in this study was the distinctiveness of the items for Drunk Driving. Based on the exploratory factor analysis of Dula (2003), we hypothesized that the items for DWI/DUI form a separate factor. The confirmatory factor analysis corroborated this, as covariances between Risky Driving, Negative Cognitive/Emotional Driving and Aggressive Driving on the one hand, and Drunk Driving on the other hand, appeared to be only moderate. This means that intoxicated driving is a form of dangerous driving behavior that can be distinguished from other risky behaviours, such as speeding, illegal passing, obstructing traffic, aggressive driving, etc. The validity of this statement was confirmed by the fact that drivers convicted for drunk driving scored highest on the Drunk Driving subscale, but lower on the other dangerous driving subscales.

This result seems to link up with recent findings that drunk driving and risky driving with non-alcohol-related traffic violations form different types of dangerous driving behavior. Golias and Karlaftis (2002) found that drivers who speed also tend to drive more dangerously in general, while drivers who report drunk driving display less seat belt use but not more speeding or general dangerous driving. Analogous to this result, we found the Risky Driving subscale (including speeding) covaries more strongly with other forms of dangerous driving (negative cognitive/emotional driving and aggressive driving) than the scale Drunk Driving. Paaver, Eenson, Pulver and Harro (2006) found evidence suggesting that speeding and drunk driving are motivated by different forms of impulsivity. While speeding is more strongly associated with the willingness and ability to take risks in situations (i.e., functional impulsivity), drunk driving is more strongly associated with thoughtlessness and inability to plan and think one's actions through (i.e., dysfunctional impulsivity).

Research literature concerning the difference between intoxicated driving and aggressive driving is scarce, although a recent study found that the crash patterns associated with aggressive driving are different from crash patterns associated with drunk driving. In comparison with the former, drunk drivers are older, more likely to crash at night and less likely to wear a seatbelt (e.g., Cook, Knight, & Olson, 2005). We think the sum of the research provides some empirical evidence to suggest drunk driving can be differentiated from other forms of dangerous driving behavior, such as risk-taking, negative cognitive (e.g., rumination) or emotional driving or aggressive driving. Therefore, we feel there is support for isolating the items for drunk driving as a separate subscale in the DDDI. The validity and the relevance of delineating well-defined subcategories of dangerous driving should be a topic for further research in which the DDDI can play a role.

However, a first limitation of this research concerns the limited number of items in the Drunk Driving scale. Consisting of only two items, certain reliability measures were rather low or were impossible to check. Therefore, further research should elaborate on the Drunk Driving subscale by adding more items to it. Additional items might concern the frequency of riding with a drunk driver or the frequency of preventing yourself (or others) from driving when drunk. A second limitation concerns the heterogeneity of the samples. Cross-cultural

comparison of the factor structure of the DDDI was limited because the samples differ on an important variable that has nothing to do with regional differences, notably offender status. Further research might respond to this limitation by collecting data from Belgian University students, Belgian Community or US traffic offenders.

A final limitation concerns social desirability. In the Belgian sample of traffic offenders, we found that scores for social desirability can explain up to 24% of the variance in the total scores, indicating that respondents with a higher need of social desirability have the tendency to underreport their degree of dangerous driving. Previous research with student samples also showed that social desirability is negatively correlated with self-reported speeding, number of accidents and tickets, and overtaking frequency (Lajunen, Corry, Summala, & Hartley, 1997). As Dula and Ballard (2003) already noticed, future studies should use a scale for social desirability. Future studies might explore scale developments that include a social desirability measure correction. In clinical and forensic application of the DDDI, a check for social desirability is recommended for evaluating possible distortions of self-presentation.

However, Galovski and Blanchard (2002) caution for another form of bias that is particularly relevant for court-referred samples such as our Belgian sample of traffic offenders. These respondents might feel justified in their dangerous driving behaviour, especially if aggressive driving behaviour was a reaction to perceived wrongdoing on the part of other drivers. Thus low endorsement of items on dangerous driving may reflect a lack of insight. This type of bias can not be controlled by including a self-report measure for social desirability. The use of behavioural or psychophysiological measures would be a first step to overcome this limitation.

The implications of this type of work are vast for those working in traffic safety and accident prevention. First, the findings indicate that meaningful divisions can and should be made when studying dangerous driving, as there were meaningful distinctions were found among different offender types in the Belgian sample. Thus, those working within the field should make efforts to move toward definitional specificity and consistency of various types of dangerous driving. Second, the measurement of dangerous driving, despite issues with social desirability, is promising in that it can be done reliably and with validity. This and other measures should be further developed and honed to provide better, more comprehensive data with less susceptibility to distortion. Third, cross-cultural studies should become more the norm and less the exception, as it seems there are universal driving experiences/issues and driver types. This of course, needs to be confirmed with more research. Similarities and differences across cultures could provide meaningful insights. Finally, these types of measures should lead us to examine who is identified for interventions to improve driving, what should be standard in terms of driver assessments and information provided in driver training, and what types of outcomes would serve best as indicators for the ultimate goal, namely, reduced crash risk.

Dula Dangerous Driving Index (©1999, Dula, C.S.)

Note: DDDI Dangerous Driving Total Score = Add all items; NCE = Negative Cognitive/Emotional Driving Subscale = Add NCE items; AD = Aggressive Driving Subscale = Add AD items; RD = Risky Driving Subscale = Add RD items.

NCE: 1. I drive when I am angry or upset.

NCE: 2. I lose my temper when driving.

NCE: 3. I consider the actions of other drivers to be inappropriate or “stupid.”

AD: 4. I flash my headlights when I am annoyed by another driver.

AD: 5. I make rude gestures (e.g., giving “the finger”; yelling curse words) toward drivers who annoy me.

AD: 6. I verbally insult drivers who annoy me.

AD: 7. I deliberately use my car/truck to block drivers who tailgate me.

AD: 8. I would tailgate a driver who annoys me.

RD: 9. I “drag race” other drivers at stop lights to get out front.

RD: 10. I will illegally pass a car/truck that is going too slowly.

AD: 11. I feel it is my right to strike back in some way, if I feel another driver has been aggressive toward me.

NCE: 12. When I get stuck in a traffic jam I get very irritated.

RD: 13. I will race a slow moving train to a railroad crossing.

RD: 14. I will weave in and out of slower traffic.

RD: 15. I will drive if I am only mildly intoxicated or buzzed.

AD: 16. When someone cuts me off, I feel I should punish him/her.

NCE: 17. I get impatient and/or upset when I fall behind schedule when I am driving.

NCE: 18. Passengers in my car/truck tell me to calm down.

NCE: 19. I get irritated when a car/truck in front of me slows down for no reason.

RD: 20. I will cross double yellow lines to see if I can pass a slow moving car/truck.

RD: 21. I feel it is my right to get where I need to go as quickly as possible.

NCE: 22. I feel that passive drivers should learn how to drive or stay home.

RD: 23. I will drive in the shoulder lane or median to get around a traffic jam.

RD: 24. When passing a car/truck on a 2-lane road, I will barely miss on-coming cars.

RD: 25. I will drive when I am drunk.

NCE: 26. I feel that I may lose my temper if I have to confront another driver.

RD: 27. I consider myself to be a risk-taker.

RD: 28. I feel that most traffic “laws” could be considered as suggestions.

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References

Baron, RA.; Richardson, DR. Human Aggression. 2nd ed.. Plenum Press; NY: 1994.

- Brislin, RW. Translation and content analysis of oral and written material. In: Triandis, HC.; Berry, JW., editors. *Handbook of cross-cultural psychology*. 1. Allyn & Bacon; Boston: 1980. p. 389-444.
- Browne, MW.; Cudeck, R. Alternative ways of assessing fit. In: Bollen, KA.; Long, JS., editors. *Testing structural equation models*. Sage; Newbury Park, CA: 1993. p. 136-162.
- Canada Safety Council. Aggressive driving study. 2001. Retrieved July 31, 2001, from the World Wide Web: <http://www.safety-council.org/news/media/releases/may15-aggdriv.html>
- Clark LA, Watson D. Constructing validity: Basic issues in scale development. *Psychological Assessment* 1995;7:309–319.
- Connell, D.; Joint, M. Driver aggression. AAA Foundation for Traffic Safety. Nov. 1996 Retrieved June 30, 1998, from the World Wide Web: <http://www.aafts.org/Text/research/agdrtxt.htm>
- Cook LJ, Knight S, Olson LM. A comparison of aggressive and DUI crashes. *Journal of Safety Research* 2005;36:491–493. [PubMed: 16298395]
- Dahlen ER, Ragan KM. Validation of the Propensity for Angry Driving Scale. *Journal of Safety Research* 2004;35:557–563. [PubMed: 15530929]
- Dahlen ER, Martin RC, Ragan K, Kuhlman MM. Driving anger, sensation seeking, impulsiveness, and boredom proneness in the prediction of unsafe driving. *Accident Analysis & Prevention* 2005;37:341–348. [PubMed: 15667821]
- Dahlen ER, White RP. The Big Five factors, sensation seeking, and driving anger in the prediction of unsafe driving. *Personality and Individual Differences* 2006;41:903–915.
- Deffenbacher JL, Oetting ER, Lynch RS. Development of a driving anger scale. *Psychological Reports* 1994;74:83–91. [PubMed: 8153239]
- Deffenbacher JL, Lynch RS, Oetting ER, Yingling DA. Driving anger: correlates of a test of state-trait theory. *Personality and Individual Differences* 2001;31:1321–1331.
- Deffenbacher JL, Lynch RS, Oetting ER, Swaim RC. The Driving Anger Expression Inventory: A measure of how people express their anger on the road. *Behaviour Research and Therapy* 2002;40:717–737. [PubMed: 12051489]
- Deffenbacher JL, Petrilli RT, Lynch RS, Oetting ER, Swaim RC. The Driver's Angry Thoughts Questionnaire: A measure of angry cognitions when driving. *Cognitive Therapy and Research* 2003;27:383–402.
- Deffenbacher JL, White GS, Lynch RS. Evaluation of two new scales assessing driving anger: The Driving Anger Expression Inventory and the Driver's Angry Thoughts Questionnaire. *Journal of Psychopathology and Behavioral Assessment* 2004;26:87–99.
- Depasquale JP, Geller ES, Clarke SW, Littleton LC. Measuring road rage – Development of the Propensity for Angry Driving Scale. *Journal of Safety Research* 2001;32:1–16.
- Dula, CS. Validity and reliability assessment of a dangerous driving self-report measure; Dissertation Abstracts International. 2003. p. 960B Document retrievable from the World Wide Web: <http://scholar.lib.vt.edu/theses/available/etd-04032003-171656/unrestricted/Dissertation2.pdf>
- Dula C, Ballard ME. Development and evaluation of a measure of dangerous, aggressive, negative emotional, and risky driving. *Journal of Applied Social Psychology* 2003;33:263–282.
- Dula CS, Geller ES. Risky, aggressive, or emotional driving: Addressing the need for consistent communication in research. *Journal of Safety Research* 2004;34:559–566. [PubMed: 14733990]
- Ellison-Potter P, Bell P, Deffenbacher J. The effects of trait driving anger, anonymity, and aggressive stimuli on aggressive driving behavior. *Journal of Applied Social Psychology* 2001;31:431–443.
- Felson, RB. A social psychological approach to interpersonal aggression. In: Van Hasselt, VB.; Hersen, M., editors. *Aggression and Violence: An Introductory Text*. Allyn & Bacon, Inc.; Boston, MA: 2000. p. 9-22.
- Galovski TE, Blanchard EB. The effectiveness of a brief psychological intervention on court-referred and self-referred aggressive drivers. *Behaviour Research and Therapy* 2002;40:1385–1402. [PubMed: 12457634]
- Geen, RG.; O'Neal, EC., editors. *Perspectives on aggression*. Academic Press; NY: 1976.
- Goldstein, AP. *The Ecology of Aggression*. Plenum Press; NY: 1994.
- Golias I, Karlaftis MG. An international comparative study of self-reported driver behavior. *Transportation Research Part F* 2002;4:243–256.

- Gulian E, Matthews G, Glendon AI, Davies DR. Dimensions of driver stress. *Ergonomics* 1989;32:585–602.
- Hu, L.; Bentler, PM. Evaluating model fit. In: Hoyle, RH., editor. *Structural equation modelling. Concepts, issues, and applications*. Sage; London: 1995. p. 76-99.
- Hu L, Bentler PM. Cutoff criteria for fit indices in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling* 1999;6:1–55.
- James, L. Testimony to House Transportation and Infrastructure Committee, Surface Transportation Subcommittee. Jul 17. 1997 Retrieved June 30, 1998, from <http://www.aloha.net/~dyc/testimony.html>
- James, L.; Nahl, D. *Road rage and aggressive driving: Steering clear of highway warfare*. Prometheus Books; Amherst, NY: 2000.
- Joint, M. Road rage. AAA Foundation for Traffic Safety. Mar. 1995 Retrieved June 30, 1998, from the World Wide Web: <http://www.aafts.org/Text/research/agdrtext.htm>
- Lajunen T, Corry A, Summala H, Hartley L. Impression management and self-deception in traffic behaviour inventories. *Personality and Individual Differences* 1997;3:341–353.
- Lajunen T, Parker D, Stradling SG. Dimensions of driver anger, aggressive and highway code violations and their mediation by safety orientation in UK drivers. *Transportation Research Part F* 1998;1:107–121.
- Lajunen T, Parker D. Are aggressive people aggressive drivers? A study of the relationship between self-reported general aggressiveness, driver anger and aggressive driving. *Accident Analysis & Prevention* 2001;33:243–255. [PubMed: 11204896]
- Lange A, Pahlich A, Sarucco M, Smits G, Dehghani B, Hanewald G. Psychometric characteristics and validity of the Dutch adaptation of the Buss-Durkee Hostility Inventory (The BDHI-D). *Behaviour Research and Therapy* 1995;33:223–227. [PubMed: 7887883]
- Larson, JA. Testimony to House Transportation and Infrastructure Committee, Surface Transportation Subcommittee. Jul 17. 1997 Retrieved June 30, 1998, from <http://www.house.gov/transportation/surface/sthearin/ist717/larson.htm>
- Martinez, R. Testimony to House Transportation and Infrastructure Committee; Surface Transportation Subcommittee. Jul 17. 1997 Retrieved June 30, 1998, from the World Wide Web: <http://www.nhtsa.dot.gov/nhtsa/announce/testimony/aggres2.html>
- Mizell, L. Aggressive driving. AAA Foundation for Traffic Safety. 1997. Retrieved June 30, 1998, from the World Wide Web: <http://www.aafts.org/Text/research/agdrtext.htm>
- Paaver M, Eensoo D, Pulver A, Harro J. Adaptive and maladaptive impulsivity, platelet monoamine oxidase (MAO) activity and risk-admitting in different types of risky drivers. *Psychopharmacology* 2006;186:32–40. [PubMed: 16557416]
- Parker D, Lajunen T, Summala H. Anger and aggression among drivers in three European countries. *Accident Analysis & Prevention* 2002;34:229–235. [PubMed: 11829293]
- Rathbone, DB.; Huckabee, JC. Controlling road rage: A literature review and pilot study. The AAA Foundation for Traffic Safety. 1999. Retrieved July 28, 2001, from the World Wide Web: <http://www.aaafoundation.org/Text/Research/RoadRageFinal.htm>
- Sarkar, S.; Martineau, A.; Emami, M.; Khatib, M.; Wallace, K. Spatial and temporal analyses of the variations in aggressive driving and road rage behaviors observed and reported on San Diego freeways. 2000. Retrieved November 21, 2000, from the World Wide Web: <http://www.aggressive.drivers.com/board/messages/25/50.html>
- Shinar D. Aggressive driving: the contribution of the drivers and the situation. *Transportation Research Part F: Traffic Psychology and Behaviour* 1998;1:137–160.
- Smith P, Waterman M, Ward N. Driving aggression in forensic and non-forensic populations: Relationships to self-reported levels of aggression, anger, and impulsivity. *British Journal of Psychology* 2006;97:387–403. [PubMed: 16848950]
- Snyder, DF. Testimony to House Transportation and Infrastructure Committee; Surface Transportation Subcommittee. Jul 17. 1997 Retrieved June 30, 1998, from the World Wide Web: <http://www.house.gov/transportation/surface/sthearin/ist717/snyder.htm>
- Sullman MJM, Gras ME, Cunill M, Planes M, Font-Mayolas S. Driving anger in Spain. *Personality and Individual Differences* 2007;42:701–713.

- Underwood G, Chapman P, Wright S, Crundall D. Anger while driving. *Transportation Research Part F* 1999;2:55–68.
- U.S. Department of Transportation, Preusser Research Group, Inc.. Capital Belt update: Beltway user focus group. National Roadway Traffic Safety Administration Report. Apr. 1998 DOT HS 808 705

Table 1
Measures of Consistency and CFA Goodness-of-Fit Indices of DDDI-scales in Three Samples Separately

Scale	α	Mean $r(ii)$	Test- Retest	χ^2	df	GFI	AGFI	RMSEA
Belgian Traffic Offenders (n=255)								
RD	0.80	0.282		47.65	35	0.89	0.83	0.038
NCED	0.75	0.253		32.04	27	0.95	0.92	0.027
AD	0.79	0.355		45.54**	14	0.89	0.77	0.094
DD	0.79	0.652		-	-	-	-	-
Total DDDI	0.90	0.240		678.78**	350	0.68	0.63	0.061
US University Sample (n=274)								
RD	0.78	0.267		58.57**	35	0.92	0.87	0.050
NCED	0.79	0.299		67.99**	27	0.91	0.86	0.075
AD	0.85	0.442		82.08**	14	0.86	0.72	0.133
DD	0.73	0.580		-	-	-	-	-
Total DDDI	0.91	0.268		907.23**	350	0.69	0.65	0.076
US Community Sample (n=190) (test-retest n =108)								
RD	0.79	0.278	10-week interval	37.53	35	0.90	0.84	0.020
NCED	0.88	0.437	.79**	60.48**	27	0.87	0.79	0.081
AD	0.85	0.455	.80**	43.54**	14	0.86	0.71	0.106
DD	0.67	0.506	.79**	-	-	-	-	-
Total DDDI	0.93	0.317	.81**	718.50**	350	0.67	0.62	0.075

Note. RD = Risky Driving; NCED = Negative Cognitive/Emotional Driving; AD = Aggressive Driving; DD = Drunk Driving; mean $r(ii)$ = mean item intercorrelation; GFI = Goodness of Fit Index; AGFI = Adjusted Goodness of Fit Index; RMSEA = Root Mean Square Error of Approximation;

**
 $p \leq 0.01$.

Table 2
Comparison of Constrained and Unconstrained Models via Multi-group CFA Involving Three Samples Simultaneously

Model	χ^2	df	χ^2/df	χ^2 diff	RMSEA	Confidence Interval RMSEA	AIC	CAIC
1-factor model								
Model 1 ^a	2277.74	1050	2.17		0.070	0.066-0.074	2613.74	3550.83
3-factor model								
Model 2	1916.90	1041	1.84		0.059	0.055-0.064	2270.90	3258.18
4-factor model								
Model 3	1703.26	1032	1.65		0.052	0.048-0.057	2075.26	3112.74
Model 4	1808.02	1088	1.66	(3)-(2) 105**	0.053	0.048-0.057	2068.02	2793.15
Model 5	1836.85	1100	1.67	(4)-(3) 29**	0.053	0.049-0.057	2072.85	2731.04
Model 6	1881.29	1156	1.63	(5)-(4) 44	0.051	0.047-0.055	2005.29	2351.12

Note.

^aModel 1 = unconstrained one-factor model; Model 2 = unconstrained three-factor model; Model 3 = unconstrained four-factor model; Model 4 = four-factor model with equal loadings; Model 5 = four-factor model with equal loadings and factor (co)variance; Model 6 = four-factor model with equal loadings, factor (co)variance and error terms; RMSEA = Root Mean Square Error of Approximation; AIC = Akaike's Information Criterion; CAIC = Consistent Akaike's Information Criterion;

p ≤ 0.01.

Table 3
Comparison of Mean Scale Scores of Specific Subgroups in Belgian Traffic Offenders Sample

	Drunk drivers (n = 101)		Speeding (n = 37)		Aggressive Drivers (n = 17)		F	LSD
	M	SD	M	SD	M	SD		
RD	15.73	3.90	18.62	4.20	21.00	7.95	12.77**	1 < 2; 1 < 3
NCED	20.16	4.73	22.00	5.76	23.59	5.29	4.36*	1 < 3
AD	10.67	3.60	11.73	4.02	14.29	5.28	6.51**	1 < 3
DD	4.12	1.53	3.30	1.60	3.18	1.29	5.64**	1 > 2
Total DDDI	50.68	11.07	55.65	12.82	62.06	17.79	7.18**	1 < 3;

Note. RD = Risky Driving; NCED = Negative Cognitive/Emotional Driving; AD = Aggressive Driving; DD = Drunk Driving; LSD = post hoc comparison according to Bonferroni's least significant method;

* $p \leq 0.05$,

** $p \leq 0.01$.