Drivers' propensity to have different types of intelligent speed adaptation installed in their cars

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A B S T R A C T

The aim of the present study was to examine if there are differences in drivers' propensity to have different types of intelligent speed adaptation installed in their cars depending on the sample of drivers (i.e. Swedish or Turkish), their aberrant driving behaviours (i.e. violations and errors), and/or the technical solution used (i.e. speed limit information, advisory, supportive and intervening systems). A sample of 224 Swedish and 316 Turkish drivers completed a questionnaire including questions based on the driver behaviour questionnaire (DBQ) as well as questions about the drivers' propensity to have different types of intelligent speed adaptation installed in their cars. The results showed that the Swedish sample of drivers was less positive than the Turkish sample of drivers towards having the advisory, supportive and intervening systems installed. Furthermore, drivers who frequently commit violations were less positive towards having any of these systems installed than were drivers who commit violations less frequently, while drivers who frequently make errors were more positive towards having the systems installed than were drivers who make errors less frequently. Both the Swedish and the Turkish sample of drivers were most positive towards having the speed limit information system installed, followed by the advisory system on second place, the supportive system on third place and lastly the intervening system on fourth place.

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1. Introduction

In 1990 Reason et al. designed a driver behaviour questionnaire (DBQ) in an attempt to distinguish between different types of aberrant driver behaviours. The driver behaviour questionnaire (DBQ; Reason, Manstead, Stradling, Baxter, & Campbell, 1990) included 50 items and the results showed that these items could be categorised into three different factors: violations (dangerous deliberate violations), errors (dangerous mistakes and slips) and lapses (harmless slips and lapses). These findings supported the view that violations and errors (mistakes, slips and lapses) have different psychological etiologies. While violations are associated with social and motivational factors, errors are knowledge-and/or cognitive-based.

Since then, the driver behaviour questionnaire (DBQ) has been extensively used, and to reflect differences in driving conditions (e.g. due to climate, traffic density, etc.), driving populations (e.g. private or professional), and special research interests (e.g. further subdivision of violations) new items have sometimes been added which has created new versions of the original questionnaire. Even though these additions of items have resulted in different factor solutions (e.g. further subdivision of violations and errors), the distinction between deliberate violations and involuntary errors, first shown by Reason et al. (1990), seems to be robust for private and professional drivers alike, both within and across different countries and cultures (for an overview see Wallén Warner, 2006). The distinction between deliberate violations and involuntary errors...
is also supported by the fact that this two-factor solution was the most stable solution (among possible solutions with two to six factors) over a 3-year follow-up study in Finland (Özkan, Lajunen, & Summala, 2006). Further research has shown that drivers’ accident involvement can be predicted by self-reported tendency to commit different types of violations (violations: Gras et al. (2006), Özkan and Lajunen (2005), Parker, Reason et al. (1995), Parker, West et al. (1995), Rimmö and Åberg (1999); aggressive violations: Özkan et al. (2006a); highway-code violations: Kontogiannis, Kossiavelou, and Marmaras (2002)). When it comes to the association between accident involvement and self-reported tendency to make errors the results are quite inconsistent. Rimmö and Åberg (1999) and Özkan et al. (2006a, with regard to Turkey but not to the other countries) found a significant association between accidents in general and self-reported tendency to make mistakes (corresponding to the original errors) while Parker, West et al. (1995) only found a significant association between active accidents (where the driver hit something) and self-reported tendency to make errors. Several studies have, however, not found any significant association between accident involvement and self-reported tendency to make errors (Kontogiannis et al. (2002), Özkan et al. (2006a), Parker, Reason et al. (1995), with regard to all countries except of Turkey).

As violations, and to some extent also errors, are related to accident involvement drivers who frequently commit violations and/or make errors are target groups for different types of traffic safety interventions. One such intervention is intelligent speed adaptation (ISA) which aims to help drivers adapt their speeds to a static or dynamic speed limit by using different techniques such as speed limit information, advisory, supportive or intervening systems (for an overview see Wallén Warner, 2006). While speed limit information systems only inform the drivers about the current speed limit, advisory systems also warn them by audible, visible, or haptic means if this limit is exceeded. Supportive systems also inform the drivers about the current speed limit and in addition they exert a counterforce in the acceleration pedal at speeds over this limit. This means that the drivers have to press the acceleration pedal three to five times harder than normal in order to exceed the speed limit. Despite the differences between these three systems it is still up to the drivers whether to use or ignore the information and warnings given. Therefore, these types of systems mainly affect drivers exceeding the speed limits due to unintended errors. Intervening systems, on the other hand, interact with the vehicle making it impossible for the drivers to exceed the speed limit which means that the systems also affect drivers who deliberately violate the speed limits (with the exception of intervening systems that can be overridden by the drivers). For more detailed examples of the different systems see Drivers’ propensity to have different types of intelligent speed adaptation installed in their cars under Section 2.2.1.

The effect of intelligent speed adaptation is promising. The results of the Swedish large-scale trial showed a decrease in speed violations at all speed limits and it was estimated that the number of people injured in traffic could be reduced by as much as 20–30%, if everyone had intelligent speed adaptation installed in their vehicles (Swedish National Road Administration, 2002). In the Australian TAC SafeCar project it was estimated that serious injury accidents would be reduced by 7% and fatal accidents by 9% if a system, combining visual and audible warnings with a counterforce in the acceleration pedal making it harder than normal to exceed the limit, was implemented on a large-scale (Regan et al., 2005). Finally, in the British external vehicle speed control (EVSC) project it was predicted that injury accidents would be reduced by 20% and fatal accidents by 37% if all vehicles were fitted with a system that limited the vehicles’ speed to the posted speed limits. If the system also lowered the speed further in case of, for example, slippery roads or major traffic incidents, injury accidents would be reduced by 36% and fatal accidents by 59% (Carsten & Tate, 2005). For any large-scale implementation of intelligent speed adaptation to become reality the drivers must however agree to have the systems installed in their cars. Previous studies dealing with acceptance show large differences depending on the type of intelligent speed adaptation targeted. While the fully intervening systems are the only systems that make drivers’ deliberate violations impossible, the acceptance of the systems among the drivers decreases with level of intervention (Adell, Vårhelyi, & Hjälmdahl, 2008; Comte, 2000; Garvill, Marell, & Westin, 2003; Päättalo, Peltoła, & Källio, 2001).

Even though quite a few studies on intelligent speed adaptation have now been conducted, the majority of them have been concentrated to the north-western region of Europe (but there have also been studies conducted in other parts of the world such as Hungary, Spain and Australia). As there are large regional differences in, for example, drivers’ aberrant driving behaviours as well as in their driving style (Özkan et al., 2006a, 2006b) it is reasonable to believe that there might also be differences between countries in drivers’ propensity to have different types of intelligent speed adaptation installed in their cars.

The aim of the present study is to examine if there are differences in drivers’ propensity to have different types of intelligent speed adaptation installed in their cars depending on the sample of drivers (i.e. Swedish or Turkish), their aberrant driving behaviours (i.e. violations and errors), and/or the technical solution used (i.e. speed limit information, advisory, supportive and intervening systems).

2. Method

2.1. Participants

Two hundred and twenty-four drivers from Sweden and 316 drivers from Turkey participated in the study. The Swedish drivers’ age ranged from 21 to 68 years, with a mean age of 40 years. Fifty-seven percent of the drivers were men while 43% were women. On average the drivers had had their driving licence for 19 years and had driven approximately 14,000 km in the previous year.
The Turkish drivers’ age ranged from 19 to 68 years, with a mean age of 32 years. Sixty-eight percent of the drivers were men while 32% were women. On average the drivers had had their driving licence for 10 years and had driven approximately 13,000 km in the previous year.

Independent-samples t-test showed that the two samples differ with regards to age ($t[449.36] = 6.70, p < .001$), gender ($t[461.80] = 2.68, p < .01$), years holding a driving licence ($t[359.88] = -8.80, p < .001$) as well as mileage driven during the previous year ($t[530.94] = -2.70, p < .01$).

2.2. Procedure

In Sweden, a postal questionnaire was sent out to 860 car owners in the county of Stockholm. In order to include a large portion of young car owners (to match the young students in the Turkish sample) stratified selection was used. From the first stratum, 500 car owners born 1989–1977 were randomly selected and from the second stratum, 360 car owners born 1976–1940 were randomly selected. After one postal reminder, 109 (22%) questionnaires were returned from car owners born 1989–1977 and 118 (33%) questionnaires were returned from car owners born 1976–1940. Of these 227 questionnaires one was excluded from further analyses because the participant had not driven during the previous year and two were excluded because the participants had missed answering more than five of the questions based on the driver behaviour questionnaire or their propensity to have different types of intelligent speed adaptation installed in their cars. The remaining 224 questionnaires were included in the Swedish sample.

In Turkey an e-mail questionnaire was distributed to 141 students at the Middle East Technical University in Ankara. In exchange for credit points, the students completed the questionnaire themselves as well as distributed it to two non-students each. Eighty-eight percent of the students who were sent the e-mail questionnaire agreed to participate in the study and collect data. According to these students, approximately 66% of the people they asked to participate agreed to complete the questionnaire. A total of 334 questionnaires were returned. Of these 334 questionnaires three were excluded from further analyses due to technical problems, 10 were excluded because the participants had not driven during the previous year and five were excluded because the participants had missed answering more than five of the questions based on the driver behaviour questionnaire (DBQ) or their propensity to have different types of intelligent speed adaptation installed in their cars. The remaining 316 questionnaires were included in the Turkish sample.

As different samplings techniques were used in Sweden and Turkey the two samples are not perfectly matched. Furthermore, they should not be seen as representative for the Swedish and/or Turkish driver in general. The implication of these constraints is further discussed under Section 4.

2.2.1. Questionnaire

A first version of the questionnaire was written in English (the researchers common language) and this version was then translated (as well as back-translated) to Swedish and Turkish, respectively. The questionnaire included questions based on the driver behaviour questionnaire (DBQ), questions about the drivers’ propensity to have different types of intelligent speed adaptation installed in their cars as well as demographic questions (age, gender, years holding a driving licence, mileage and accident involvement). Finally, the questionnaire also included questions based on the theory of planned behaviour (TPB) and the traffic locus of control (T-LOC) but these questions will not be addressed here.

2.2.1.1. Driver behaviour questionnaire (DBQ). In the present study, the extended version of the driver behaviour questionnaire (DBQ; Lawton, Parker, Manstead, & Stradling, 1997; Parker, Lajunen, & Stradling, 1998) was used. This version consists of 28 items. Four of these items target aggressive violations (e.g. to sound your horn to indicate your annoyance), eight items target ordinary violations (e.g. to pull out at a junction so far that the driver with right of way has to stop and let you pass), eight items target errors (e.g. to misjudge the speed of another vehicle when overtaking), and eight items target lapses (e.g. to forget where you left your car in a car park). For each item the participants are asked to indicate how often they had committed the behaviour, during the previous year, on a six-point scale (1 = never, 6 = very often).

2.2.1.2. Drivers’ propensity to have different types of intelligent speed adaptation installed in their cars. Four different systems of intelligent speed adaptation were described and for each of the systems the participants were asked to indicate, on a seven-point scale (1 = definitely not; 7 = definitely) whether or not they would like to have the system installed in their cars.

2.2.1.3. The speed limit information system. The system shows the current speed limit on the dashboard below the speedometer.

2.2.1.4. The advisory system. The system shows the current speed limit on the dashboard below the speedometer. In addition the system also warns the driver, with a flashing red light and sound signals, if the speed limit is exceeded.

2.2.1.5. The supportive system. The system shows the current speed limit on the dashboard below the speedometer. In addition the system also exerts a counterforce in the acceleration pedal at speeds over the speed limit. This means that the driver has to press the acceleration pedal three to five times harder than normal in order to exceed the speed limit.
22.1.6. The intervening system. The system shows the current speed limit on the dashboard below the speedometer. In addition, the system also interacts with the vehicle, making it impossible for the driver to exceed the speed limit.

2.3. Analyses

Using SPSS 13.0 any remaining missing values (0.7%) were replaced with means before the suitability of data for factor analysis was assessed. The correlation matrices of the items included in the driver behaviour questionnaire (DBQ: due to their size they are not included in the present paper but can be obtained from the corresponding author) for the Swedish as well as for the Turkish sample of drivers both included several correlations greater than .3, the KMO-values were both larger than .6 and Barlett’s tests of sphericity were both significant which show that the data was suitable for principal component analysis (Pallant, 2001). The items were subsequently subjected to a principal component analysis (PCA) with oblimin rotation and two factors were extracted based on the theoretical and empirical evidence of a robust two-factor solution representing violations and errors. Indexes were then created by taking the mean of the eight items targeting violations (after excluding four items which were supposed to target violations but which did load on errors; see the results section for further description) and the 16 items targeting errors.

Thereafter, four hierarchical multiple regressions (one for each system described) were performed in order to examine how much of the variance in drivers’ propensity to have different types of intelligent speed adaptation installed in their cars could be explained by the sample of drivers (from Sweden or Turkey) and their aberrant driving behaviour (measured by the driver behaviour questionnaire, DBQ). To control for age, gender and years holding a driving licence these variables were entered into the model in the first block while sample of drivers was entered in the second block and violations and errors in the third block. Within each block the variables were entered into the equation simultaneously resulting in a standard multiple regression for each block.

Finally, paired sample t-test was used in order to examine differences in drivers’ propensity to have different types of intelligent speed adaptation installed in their cars based on the technical solution used.

3. Results

Table 1 shows how the items of the driver behaviour questionnaire (DBQ) loaded on the two factors errors and violations. The table also shows that in both samples of drivers some of the items which were supposed to target violations did in fact load on errors. In the Swedish sample of drivers these items were Drive so close to the car in front that it would be difficult to stop in an emergency and Pull out of a junction so far that the driver with right of way has to stop and let you out. In the Turkish sample of drivers the items were Cross a junction knowing that the traffic lights have already turned against you, Stay in a motorway lane that you know will be closed ahead until the last minute before forcing your way into the other lane and Pull out of a junction so far that the driver with right of way has to stop and let you out (same as in Sweden). These kinds of discrepancies have already been described in other studies (e.g. Özkan et al., 2006a) and all four items were therefore excluded from further analysis as it seems like the Swedish and the Turkish drivers conceptualize these items as unwanted results of involuntary actions rather than conscious deviation from a rule or safe practice. The reasons (e.g. lack of traffic knowledge) of this outcome would be interesting to investigate in future studies.

Indexes for violations and errors were then created by taking the mean of the eight items targeting violations (after excluding the four items mentioned above) and the 16 items targeting errors, Cronbach’s alpha for violations were .74 and .83, and for errors .81 and .91, for the Swedish and the Turkish sample of drivers, respectively.

Table 2 shows that age, gender and years holding a driving licence did not make any significant contribution to drivers’ propensity to have the speed limit information system installed in their cars, while sample of drivers could explain 1.0% of the variance in drivers’ propensity to have the system installed. Finally, violations and errors could together explain an additional 2.4% of the variance in drivers’ propensity to have the speed limit information system installed in their cars. Only violations (β = .19, \( N = 540, p < .001 \)) did however make a unique significant contribution to the prediction of drivers’ propensity to have the system installed, and the results show that drivers who commit violations more frequently were less likely to have the system installed than were drivers who commit violations less frequently.

Table 2 also shows that age, gender and years holding a driving licence could together explain 2.0% of the variance in drivers’ propensity to have the advisory system installed in their cars. The sample of drivers could then explain an additional 7.5% of the variance in drivers’ propensity to have the system installed, with the Swedish sample of drivers being less positive than the Turkish sample of drivers to have the system installed (β = –.33, \( N = 540, p < .001 \)). Finally, violations and errors could explain an additional 4.2% of drivers’ propensity to have the advisory system installed in their cars. Both violations (β = –.25, \( N = 540, p < .001 \)) and errors (β = .14, \( N = 540, p < .01 \)) made unique significant contributions to the prediction of drivers’ propensity to have the system installed. The results show that drivers who commit violations more frequently were less likely to have the system installed than were drivers who commit violations less frequently and drivers who make errors more frequently were more likely to have the system installed than were drivers who make errors less frequently.

Table 2 then shows that age, gender and years holding a driving licence could together explain 4.5% of the variance in drivers’ propensity to have the supportive system installed in their cars. The sample of drivers could then explain an additional 7.6% of the variance in drivers’ propensity to have the system installed, with the Swedish sample of drivers being less
Table 1
Explained variance, mean (m), standard deviation (sd) and factor loadings for errors (E) and violations (V) in the Swedish and Turkish sample of drivers, respectively.

<table>
<thead>
<tr>
<th></th>
<th>Sweden</th>
<th></th>
<th></th>
<th>Turkey</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m</td>
<td>sd</td>
<td>E</td>
<td>V</td>
<td>m</td>
<td>sd</td>
</tr>
<tr>
<td>Explained variance (%)</td>
<td>18.49</td>
<td>12.41</td>
<td></td>
<td>37.84</td>
<td>8.27</td>
<td></td>
</tr>
<tr>
<td>Total explained variance (%)</td>
<td>30.90</td>
<td></td>
<td></td>
<td>46.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Items and their factor loadings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>av Sound your horn to indicate your annoyance to another road user</td>
<td>2.00</td>
<td>1.06</td>
<td>.69</td>
<td>3.02</td>
<td>1.46</td>
<td>.54</td>
</tr>
<tr>
<td>av Become angered by a certain type of driver and indicate your hostility by whatever means you can</td>
<td>1.68</td>
<td>0.77</td>
<td>.60</td>
<td>2.26</td>
<td>1.29</td>
<td>.59</td>
</tr>
<tr>
<td>av Become angered by another driver and give chase with the intention of giving him/her a piece of your mind</td>
<td>1.14</td>
<td>0.48</td>
<td>.48</td>
<td>1.70</td>
<td>1.16</td>
<td>.37</td>
</tr>
<tr>
<td>av Race away from traffic lights with the intention of beating the driver next to you</td>
<td>2.25</td>
<td>1.24</td>
<td>.63</td>
<td>1.88</td>
<td>1.23</td>
<td>.70</td>
</tr>
<tr>
<td>av Disregard the speed limit on a motorway</td>
<td>3.75</td>
<td>1.60</td>
<td>.71</td>
<td>2.26</td>
<td>1.49</td>
<td>.76</td>
</tr>
<tr>
<td>av Disregard the speed limit on a residential road</td>
<td>2.15</td>
<td>1.19</td>
<td>.59</td>
<td>2.89</td>
<td>1.41</td>
<td>.80</td>
</tr>
<tr>
<td>av Overtake a slow driver on the inside</td>
<td>2.24</td>
<td>1.31</td>
<td>.64</td>
<td>2.72</td>
<td>1.38</td>
<td>.73</td>
</tr>
<tr>
<td>av Drive so close to the car in front that it would be difficult to stop in an emergency</td>
<td>2.33</td>
<td>1.04</td>
<td>.38</td>
<td>1.93</td>
<td>1.09</td>
<td>.41</td>
</tr>
<tr>
<td>av Cross a junction knowing that the traffic lights have already turned against you</td>
<td>1.57</td>
<td>0.69</td>
<td>.47</td>
<td>1.87</td>
<td>1.06</td>
<td>.43</td>
</tr>
<tr>
<td>av Stay in a motorway lane that you know will be closed ahead until the last minute before forcing your way into the other lane</td>
<td>2.08</td>
<td>1.23</td>
<td>.63</td>
<td>1.89</td>
<td>1.14</td>
<td>.48</td>
</tr>
<tr>
<td>av Pull out of a junction so far that the driver with right of way has to stop and let you out</td>
<td>1.52</td>
<td>0.68</td>
<td>.41</td>
<td>1.84</td>
<td>1.04</td>
<td>.47</td>
</tr>
<tr>
<td>av Drive when you suspect you might be over the legal blood alcohol limit</td>
<td>1.52</td>
<td>0.53</td>
<td>.41</td>
<td>1.63</td>
<td>1.06</td>
<td>.41</td>
</tr>
<tr>
<td>e Queuing to turn right onto a main road, you pay such close attention to the main stream of traffic that you nearly hit the car in front</td>
<td>1.67</td>
<td>0.73</td>
<td>.52</td>
<td>1.89</td>
<td>0.99</td>
<td>.65</td>
</tr>
<tr>
<td>e Attempt to overtake someone that you had not noticed to be signalling a left turn</td>
<td>1.41</td>
<td>0.65</td>
<td>.45</td>
<td>1.69</td>
<td>0.90</td>
<td>.78</td>
</tr>
<tr>
<td>e Miss “Give Way” signs and narrowly avoid colliding with traffic having right of way</td>
<td>1.45</td>
<td>0.61</td>
<td>.66</td>
<td>1.67</td>
<td>0.93</td>
<td>.81</td>
</tr>
<tr>
<td>e On turning right nearly hit a cyclist who has come up on your inside</td>
<td>1.68</td>
<td>0.71</td>
<td>.61</td>
<td>1.67</td>
<td>0.92</td>
<td>.74</td>
</tr>
<tr>
<td>e Brake too quickly on a slippery road or steer the wrong way in a skid</td>
<td>1.87</td>
<td>0.76</td>
<td>.69</td>
<td>2.09</td>
<td>1.12</td>
<td>.54</td>
</tr>
<tr>
<td>e Underestimate the speed on an oncoming vehicle when overtaking</td>
<td>1.99</td>
<td>0.86</td>
<td>.48</td>
<td>2.00</td>
<td>1.02</td>
<td>.56</td>
</tr>
<tr>
<td>e Fail to check in your rear-view mirror before pulling out, changing lanes, etc.</td>
<td>1.80</td>
<td>0.76</td>
<td>.48</td>
<td>2.14</td>
<td>1.56</td>
<td>.53</td>
</tr>
<tr>
<td>e Fail to notice that pedestrians are crossing when turning into a side street from a main road</td>
<td>1.79</td>
<td>0.70</td>
<td>.54</td>
<td>1.80</td>
<td>1.02</td>
<td>.62</td>
</tr>
<tr>
<td>l Attempt to drive away from the traffic lights in third gear</td>
<td>1.61</td>
<td>0.84</td>
<td>.52</td>
<td>1.44</td>
<td>0.95</td>
<td>.83</td>
</tr>
<tr>
<td>l Misread the signs and exit from a roundabout on the wrong road</td>
<td>2.01</td>
<td>0.76</td>
<td>.58</td>
<td>1.54</td>
<td>0.88</td>
<td>.83</td>
</tr>
<tr>
<td>l Hit something when overtaking that you had not previously seen</td>
<td>1.58</td>
<td>0.63</td>
<td>.52</td>
<td>1.90</td>
<td>1.01</td>
<td>.55</td>
</tr>
<tr>
<td>l Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers</td>
<td>1.72</td>
<td>0.83</td>
<td>.55</td>
<td>1.60</td>
<td>0.92</td>
<td>.78</td>
</tr>
<tr>
<td>l Forget where you left your car in a car park</td>
<td>2.31</td>
<td>1.11</td>
<td>.45</td>
<td>2.24</td>
<td>1.23</td>
<td>.38</td>
</tr>
<tr>
<td>l Intending to drive to destination A, you “wake up” to find yourself on the road to destination B, perhaps because the latter is your more usual destination</td>
<td>2.06</td>
<td>0.96</td>
<td>.34</td>
<td>2.13</td>
<td>1.20</td>
<td>.62</td>
</tr>
<tr>
<td>l Get into the wrong lane approaching a roundabout or a junction</td>
<td>2.08</td>
<td>0.79</td>
<td>.51</td>
<td>1.87</td>
<td>1.00</td>
<td>.46</td>
</tr>
<tr>
<td>l Realise that you have no clear recollection of the road along which you have just been travelling</td>
<td>2.34</td>
<td>1.07</td>
<td>.40</td>
<td>2.21</td>
<td>1.10</td>
<td>.58</td>
</tr>
</tbody>
</table>

av = aggressive violations, ov = ordinary violations, e = errors, l = lapses. For clarity all factor loadings <.30 are excluded.

Table 2
The mean (m) and standard deviation (sd) for age, gender, years holding a driving licence as well as for violations and errors. The four last columns show the p-values for regression analyses on the speed limit information, advisory, supportive and intervening systems, respectively.

<table>
<thead>
<tr>
<th></th>
<th>m</th>
<th>sd</th>
<th>Information</th>
<th>Advisory</th>
<th>Supportive</th>
<th>Intervening</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>β</td>
<td>β</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>Step 1 (R² change (%))</td>
<td>0.1</td>
<td>.20</td>
<td>.45</td>
<td>.35</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>35.69</td>
<td>13.50</td>
<td>-.17</td>
<td>.09</td>
<td>.12</td>
<td>.16</td>
</tr>
<tr>
<td>Gender</td>
<td>1.63</td>
<td>0.48</td>
<td>.01</td>
<td>.00</td>
<td>.05</td>
<td>.03</td>
</tr>
<tr>
<td>Years holding a driving license</td>
<td>13.78</td>
<td>12.28</td>
<td>.10</td>
<td>-.05</td>
<td>-.18</td>
<td>-.14</td>
</tr>
<tr>
<td>Step 2 (R² change (%))</td>
<td>1.0</td>
<td>.75</td>
<td>.76</td>
<td>.78</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>Sample (1 = Turkey; 2 = Sweden)</td>
<td>1.41</td>
<td>0.49</td>
<td>.09</td>
<td>-.33</td>
<td>.33</td>
<td>-.34</td>
</tr>
<tr>
<td>Sample (1 = Turkey; 2 = Sweden)</td>
<td>2.4</td>
<td>4.2</td>
<td>4.3</td>
<td>.64</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>Step 3 (R² change (%))</td>
<td>2.22</td>
<td>0.81</td>
<td>-.19</td>
<td>-.25</td>
<td>-.25</td>
<td>-.30</td>
</tr>
<tr>
<td>Violations</td>
<td>1.85</td>
<td>0.59</td>
<td>.09</td>
<td>.14</td>
<td>.10</td>
<td>.20</td>
</tr>
</tbody>
</table>

* Significant on a 5% level.
** Significant on a 1% level.
*** Significant on a 0.1% level.
positive than the Turkish sample of drivers to have the system installed ($\beta = -.33, N = 540, p < .001$). Finally, violations and errors could explain an additional 4.3% of drivers’ propensity to have the supportive system installed in their cars. Both violations ($\beta = -.25, N = 540, p < .001$) and errors ($\beta = .10, N = 540, p < .05$) made unique significant contributions to the prediction of drivers’ propensity to have the system installed. The results show that drivers who commit violations more frequently were less likely to have the system installed than were drivers who commit violations less frequently and drivers who make errors more frequently were more likely to have the system installed than were drivers who make errors less frequently.

Finally, Table 2 shows that age, gender and years holding a driving licence could together explain 3.5% of the variance in drivers’ propensity to have the intervening system installed in their cars. The sample of drivers could then explain an additional 7.8% of the variance in drivers’ propensity to have the system installed, with the Swedish sample of drivers being less positive than the Turkish sample of drivers to have the system installed ($\beta = -0.34, N = 540, p < .001$). Finally, violations and errors could explain an additional 6.4% of drivers’ propensity to have the intervening system installed in their cars. Both violations ($\beta = -0.30, N = 540, p < .001$) and errors ($\beta = 0.20, N = 540, p < .001$) made unique significant contributions to the prediction of drivers’ propensity to have the system installed. The results show that drivers who commit violations more frequently were less likely to have the system installed than were drivers who commit violations less frequently and drivers who make errors more frequently were more likely to have the system installed than were drivers who make errors less frequently.

In the above analyses the index for violations included eight items of which two were directly related to exceeding the speed limits (i.e. Disregard the speed limit on a motorway and Disregard the speed limit on a residential road). When these two items were excluded from the index and the analyses rerun violations still made unique significant contributions to the prediction of drivers’ propensity to have any of the four systems installed, with drivers who commit violations (excluding exceeding the speed limits) more frequently being less likely to have the systems installed than drivers who commit violations less frequently.

Finally, Table 3 then shows that the drivers in both the Swedish and the Turkish sample were most positive towards having the speed limit information system installed followed by the advisory system and the supportive system, while they were most negative towards having the intervening system installed.

4. Discussion

The aim of the present study was to examine if there are differences in drivers’ propensity to have different types of intelligent speed adaptation installed in their cars depending on the sample of drivers (i.e. Swedish or Turkish), their aberrant behaviours (i.e. violations and errors), and/or the technical solution used (i.e. speed limit information, advisory, supportive and intervening systems).

The results show that the Swedish sample of drivers are less positive than the Turkish sample of drivers towards having the advisory, supportive and intervening systems installed in their cars, while no difference was found for the speed limit information system. It is, however, important to remember that the sampling techniques used were very different in Sweden and in Turkey. In Sweden, a postal questionnaire was sent to car owners in the county of Stockholm and a stratification procedure was applied which probably resulted in the sample being fairly representative for the region – but not for the Swedish driver in general. In Turkey, an e-mail questionnaire was distributed to students at the Middle East Technical University who were each then asked to recruit two non-students. Even though students are coming to the Middle East Technical University from almost every part of Turkey, and University records show the students’ family backgrounds are more or less reflective of Turkey as a whole, it still raises questions about the sample’s representativeness. This means that the differences found in drivers’ propensity to have different types of intelligent speed adaptation installed in their cars cannot be seen as differences due to the drivers’ country of residence – only to differences between the two samples of drivers.
Looking at previous research about acceptance of intelligent speed adaptation, most studies have only been conducted in one country and different measurements of acceptance (incl. the acceptance scale by Van der Laan, Heino, and De Waard (1997), drivers’ propensity to install or activate/deactivate the system, drivers’ willingness to keep a system after having tested it as well as drivers’ willingness to pay for the system, etc.; see Adell et al., 2008; Comte, 2000; Garvill et al., 2003; Päätalo et al., 2001) as well as different types of intelligent speed adaptation have been used. Only one other study has, as far as the authors are aware, used the same measurements and design in more than one country. In this study Adell et al. (2008) compared Hungarian and Spanish drivers’ propensity to keep an advisory system (i.e. flashing red light and sound signals when exceeding the speed limits) and a supportive system (i.e. counterforce in the acceleration pedal when exceeding the speed limits) after having tried the systems for 1 month each. No significant differences were found between countries with regards to drivers’ propensity to keep the advisory (Hungary: 65%; Spain: 63%) or supportive (Hungary: 50%; Spain: 53%) systems. The Hungarian and Spanish drivers’ willingness to keep the supportive system was also compared with results from a previous Swedish study. This showed that Swedish drivers (28%) were less positive towards keeping the system than were Hungarian (50%) and Spanish (53%) drivers. These results do suggest that drivers in Northern Europe might be less accepting towards intelligent speed adaptation than are drivers from Southern Europe.

One possible explanation to why drivers in Northern Europe might be less accepting towards intelligent speed adaptation than are drivers from Southern Europe could be differences in drivers’ interest for technology in general. In a recent Swedish study (Svensk et al., 2009), drivers were invited to try a newly developed system for intelligent speed adaptation by downloading it to their mobile phones. Among the drivers who choose to try the system 69% stated that they were very interested in technology. To further examine the link between drivers’ general interest in technology and their propensity to have different types of intelligent speed adaptation installed it would be interesting to include questions about interest in technology in future studies of acceptance of intelligent speed adaptation. Another possible explanation to why drivers in Southern Europe might be more accepting towards intelligent speed adaptation than are drivers from Northern Europe could be differences in drivers’ perception of their traffic problems. It has, for example, been shown that the more externally (others, environment/vehicle, and fate) oriented drivers are, the more accepting they are towards intelligent speed adaptation (Özkan, Lajunen, & Kaistinen, 2005).

The present study also shows that drivers who frequently commit violations (including or excluding speeding items) are less positive towards having any of the four systems described installed than are drivers who commit violations less frequently. This is in accordance with previous research which shows that drivers with low self-reported safety skills rate the acceptability of intelligent speed adaptation as low (Özkan et al., 2005) and the same holds for drivers who engage in higher speeds, as measured by the driving style questionnaire (DSQ) or by observed speed (Jamson, 2006). Furthermore, the present study shows that drivers who frequently make errors are more positive towards having the supportive, advisory and intervening systems installed than are drivers who make errors less frequently. This is also in accordance with previous research which shows that drivers with low self-reported perceptual-motor skills rate the acceptability of intelligent speed adaptation as high (Özkan et al., 2005). The fact that drivers who frequently make errors are positive towards having these systems installed suggests that they see them as useful aids in their driving.

Finally, the present study shows that both the Swedish and the Turkish sample of drivers are most positive towards having the speed limit information system installed followed by the advisory system and then the supportive system, while they were most negative towards having the intervening system installed. This is in accordance with previous research which shows that drivers’ acceptance of a system decreases with the systems level of intervention both in Turkey (Özkan et al., 2005) and in other countries (Adell et al., 2008; Comte, 2000; Garvill et al., 2003; Päätalo et al., 2001).

Unfortunately, only the systems, which are less accepted by the drivers, make it impossible for the drivers to deliberately violate the speed limits (with the exception of intervening systems that can be overridden by the drivers). One way to increase the acceptance of intervening systems could be to combine them with other less intervening systems depending on the traffic environment (e.g. a system that is intervening in urban areas but only advisory or supportive in rural areas). This alternative is supported by Wallén Warner (2005) who showed that an advisory system (i.e. flashing red light and sound signals when exceeding the speed limits) was more desirable in urban areas (especially close to schools, day nurseries and housing estates) than in rural areas (especially on roads with 90 and 110 km/h speed limits).

Another way to increase the acceptance of all systems could be to combine them with economic incentives (e.g. lower insurance premium on the car if intelligent speed adaptation is installed). In Sweden, 95 test drivers participated in a project aiming to study the effect of economic incentives (Hultkrantz & Lindberg, 2003). Half of the test drivers received a bonus of 200 SEK (approximately 20 EUR) while the other half received a bonus of 500 SEK (approximately 50 EUR). The drivers’ speeding behaviours were then registered and for every minute they spent speeding a certain amount, ranging from 0 to 2 SEK (approximately 0.2 EUR), were subtracted from their bonuses. The results showed that even these relatively small incentives resulted in reduced amount of time spent speeding.

To present the systems as complementary aids after having evaluated the drivers’ driving style (e.g. number of violations and errors) and skills (e.g. safety skills and perceptual-motor skills) in driving schools or internet-based platforms for feedback-based evaluation, might also be a way to increase the acceptance. As errors are the result of cognitive processing problems it can be assumed that drivers who frequently commit errors might be willing to compensate their processing problems with in-vehicle technologies. Violations, on the other hand, are mostly motivational and contextual and therefore a redefinition of a good driver (e.g. both highly skillful and safety oriented) might activate motivational and contextual sources for the acceptance of intelligent speed adaptation.
One limitation with the present study is that the drivers were asked about systems that they have not had the opportunity to test and therefore their answers are based on expectations rather than on experience. At the same time as previous research has shown that acceptance of a system changes with use (Almqvist & Nygård, 1997; Comte, 2000; Comte, Wardman, & Whelan, 2000; Persson, Towliat, Almqvist, Rissler, & Magdeburg, 1993; Vlassenroot et al., 2007). Whether or not the Swedish and the Turkish sample of drivers would be affected in the same way if they were given the opportunity to test the systems targeted in the present study is not known but further research is needed.

To sum up, the Swedish sample of drivers is less positive than the Turkish sample of drivers towards having the advisory, supportive and intervening systems installed in their cars. Furthermore, drivers who frequently commit violations are less positive towards having any of these systems installed than are drivers who commit violations less frequently. Drivers who frequently make errors are, on the other hand, more positive towards having the systems installed than are drivers who make errors less frequently which suggests that these drivers expect the systems to be useful aids in their driving. Finally, both the Swedish and the Turkish sample of drivers are most positive towards having the speed limit information system installed, followed by the advisory system on second place, the supportive system on third place and lastly the intervening system on fourth place.

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