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THE ADAPTATION TEST: THE DEVELOPMENT OF A METHOD TO MEASURE SPEED ADAPTATION TO TRAFFIC COMPLEXITY

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Summary: To monitor novice driver performance in the first years of solo driving, a test aimed at assessing speed adaptation to the traffic situation was developed and evaluated. The Adaptation Test consisted of 18 traffic scenes presented in two (almost) identical photographs, which differed in one single detail, increasing the situation's complexity. The difference in reported speed between the two pictures was used as an indication of drivers' adaptation of speed to the complexity of the traffic situation. A previous study showed that novice, unsafe and overconfident drivers, as identified in an on-road driving assessment, performed worse on the Adaptation Test (i.e. less often reported a lower speed in the more complex situation). The analysis of new data in this paper shows no correlation between performance on the Adaptation Test and self-reported crashes, and that after two years, experienced drivers had improved their performance on the Adaptation Test just as much as novice drivers.

INTRODUCTION

For safe driving, a driver's capabilities have to match (or exceed) the task demands of a traffic situation (Fuller, 2005). A driver can influence the tasks demands by, for example, adjusting speed or headway. It is assumed that the decision to increase or decrease task demands, is influenced by the driver's assessment of the complexity of the traffic situation on the one hand, and of his driving ability on the other hand. Balancing task demands and capabilities has been named "calibration". It is postulated that novice drivers are particularly poor at calibration and that improvement in calibration explains the steady decrease in crash rates in the first months after licensing (Brown & Groeger, 1988; Gregersen, 1995; Kuiken & Twisk, 2001).

To measure the effect of perceived complexity on adaptation to task demands a new method, The Adaptation Test, was developed and evaluated (De Craen, Twisk, Hagenzieker, Elffers & Brookhuis, 2008). The present paper reports additional results, regarding the relation with self-reported crashes and the development of adaptation over time.

The Adaptation Test

The Adaptation Test consisted of 18 traffic scenes presented in two (almost) identical photographs, which differed in one single detail, thereby increasing the *complexity of the situation*. As the pictures were presented randomly and participants could not return to previous

pictures, participants were kept unaware of the varying level of complexity. With the use of photographs, task complexity can be manipulated, which is fairly impossible in a more natural environment. In addition, the easy implementation of photographs on a website makes this test very cost-effective and applicable in a longitudinal study with many participants.

To study the extent to which complexity affects *adaptation to task demands* we used driving speed, because reducing speed is the most straightforward way to decrease task demands (e.g. Quimby & Watts, 1981). The respondents were asked to assess at what speed they *would* drive in the depicted situations. Neither in the instructions nor in the pictures was an explicit reference made to the legal speed limit. The situations were selected in such a manner that the "extra" element would increase the complexity of the situation, without legally obliging the driver to lower his speed. In Figure 1, for instance, a driver is allowed to drive at the same speed, and has right of way, in both situations.

Figure 1. An example of a simple (left) and complex (right) situation in the Adaptation Test

Hypotheses

A previous evaluation (De Craen et al., 2008) confirmed that the Adaptation Test meets the following basic criteria:

1. In general, drivers adapt their speed to the complexity of the situation (report lower driving speeds in the more complex traffic situations);
2. Inexperienced, overconfident, or unsafe drivers (as assessed in a driving assessment) perform worse on the Adaptation Test than more experienced, well calibrated and safe drivers.

Because poor calibration is assumed to be related to the high crash risk of young novice drivers, a relation between performance on the Adaptation Test and (self-reported) crashes is expected. In addition, as the crash risk of young novice drivers decreases over time, and this decrease has been related to an improvement in calibration skills, it is expected that the performance of young novice drivers on the Adaptation Test improves over time. In the present study these two additional criteria for the Adaptation Test are tested:

3. Is there a relation between performance on the Adaptation Test and (self-reported) crashes?;
4. Do young novice drivers improve their performance on the Adaptation Test in the first two years of solo driving, while the performance of the experienced drivers does not change?

METHOD

Participants

The total sample consisted of novice (n = 434, 52% male) and experienced drivers (n = 173, 49% male). At the start of the study, the novice drivers had two weeks of driving experience (Mean age = 20; SD = 1.8) and the experienced group at least 10 years driving experience (Mean age = 41; SD = 5.6).

Additionally, 130 drivers (83 novice drivers and 47 experienced drivers) were randomly drawn from this sample, and participated in an on-road driving assessment in April 2006. Finally 112 drivers (77 novice drivers and 35 experienced drivers) participated in a second driving assessment in April 2007.

Design

In order to study the *development* of calibration in the first years of solo driving, the participants filled out six questionnaires during two years (from October 2005 until May 2007). The questionnaires were evenly spaced over the two-year period. That is, there were exactly four months between each questionnaire.

Instruments

The Adaptation Test. Because we wanted to avoid the risk that participants started recognising the 18 situations of the Adaptation Test, they were divided over three subsequent questionnaires. So, the first three questionnaires each contained six different traffic situations, and these situations were assessed a second time in the final three questionnaires. The responses to the eighteen traffic situations collected in the first three questionnaires were used for the evaluation of the Adaptation Test (De Craen et al., 2008). The present paper reports the results of the last three questionnaires.

Questionnaire. The questionnaires were completed on a website. Besides the six situations of the Adaptation Test, the questionnaires also included background questions (age, occupation, etc.). In five questionnaires, drivers reported whether they had been in a crash in the preceding four months (this was not asked in the first questionnaire because the novice drivers had no driving experience at this point). Only three crashes with personal injury were reported, compared to 142 crashes with material damage only. Therefore, in this study no distinction will be made in the severity of the crash.

On-road driving assessment. A driving assessment was conducted, consisting of half an hour driving on different types of road. Examiners rated drivers on their ability to drive safely on a scale from 0 to 10; 5.5 being the pass-fail criterion in a real driving test.

Data Analysis

The difference between reported speed in the simple and complex version was used for between group analyses. A response was considered ‘correct’ if the reported speed was lower in the complex situation than in the corresponding simple situation; in this case one point was assigned.

A higher speed in the complex situation was regarded to be equally unwanted as was no speed change, and no points were assigned. When for one of the photos no speed was reported, or the speed was unlikely to be correct (e.g. 555 km/h), the score was coded as 'missing' (in .3 % of all entries). Because of these missing values, the percentage of correct responses was used for analysis and not the total sum of scores. This adaptation score (i.e. percentage of correct responses) was only calculated for participants with at least six valid scores.

Analysis of variance of the adaptation score was used to test for significant differences between groups ($\alpha = .05$). For the evaluation of the situations, repeated measures analysis with reported speed on the simple and complex situation (i.e. not the adaptation score) as the within-subjects-factor was used ($\alpha = .05$).

RESULTS

Repeated Measures analysis, with reported speed on the simple and complex situation as within-subjects-factor, was carried out for all situations and for each of the eighteen situations separately. The results showed a main effect of complexity; the mean reported speed was significantly lower in the complex situations than in the simple situations ($F_{1,603} = 655.10$; $p < .001$), with a large effect size ($\eta_P^2 = 0.52$). See De Craen et al. (2008) for more details.

Relation with Experience, Gender, Driving Skills and Self-assessed Skills

As can be seen in Table 1, a first evaluation of the Adaptation Test (see De Craen et al., 2008, for further details) found main effects of gender, level of driving experience, driving skills, and self-assessment.

Table 1. Summary of the first evaluation of the Adaptation Test

Subgroups	*N*	*Adaptation score*		*ANOVA*	*Effect size* η_P^2
		Mean	*SD*		
Gender					
Males	301	43	1.2	$F_{1,603} = 8.42$ $p < .01$	.01
Females	306	38	1.2		
Experience					
Experienced	173	45	1.4	$F_{1,603} = 26.77$ $p < .001$	.04
Novice	434	36	.9		
Driving skills					
Safe drivers	102	42	1.9	$F_{1,128} = 12.45$ $p < .01$	.09
Unsafe drivers	28	28	3.6		
Self-assessment					
Well-calibrated	83	43	2.1	$F_{2,127} = 6.46$ $p < .01$	.09
Insecure	27	38	3.6		
Overconfident	20	26	4.2		

Male drivers performed significantly better on the Adaptation Test than female drivers. Experienced drivers performed significantly better than novice drivers. Drivers who scored higher than 5.5 on the driving assessment (i.e. would have passed in a real driving test)

performed significantly better than drivers scoring less than 5.5. Finally, well-calibrated drivers (i.e. share the examiner's opinion about their driving skills) performed better on the Adaptation Test than insecure drivers (i.e. were less confident about their driving skills, but passed the driving assessment), and overconfident drivers (i.e. were confident about their driving skills, but failed the driving assessment) who performed worst on the Adaptation Test. No interaction effects were found.

Relation Adaptation Test with Self-reported Crashes

During the two years of the study 121 participants reported a total of 145 crashes. Table 2 shows that there was no difference between males and females in the number of reported crashes. The difference in number of crashes between the novice and the experienced drivers was significant ($X^2_{1,N=585} = 19.17$; $p < .001$). There was no difference between drivers who had reported a crash and who had not reported a crash in their performance on the Adaptation Test. Both groups had an average of 40% correct responses to the situations.

Table 2. Total number of self-reported crashes in two years

		No crash		*One or more crashes*	
Subgroups	*N*	*n*	*%*	*n*	*%*
Gender					
Males	292	233	80 %	59	20 %
Females	293	231	79 %	62	21 %
Experience					
Experienced	166	151	91 %	15	9 %
Novice	419	313	75 %	106	25 %
Total	585	464	79 %	121	21 %
% correct responses on Adaptation Test		40 %		40 %	

Development Adaptation Test in Two Years of Solo Driving

Figure 2 shows that experienced drivers performed better on the Adaptation Test during the two years of the study. The first three questionnaires (1, 2 and 3) each contained a different set of six traffic situations, and these situations were assessed a second time in the final three questionnaires (4, 5 and 6). The differences between the sets of traffic situations that were used in each questionnaire are also visible in Figure 2. Apparently, the situations 7 to 12 (questionnaire 2 and 5) were easier to assess than the situations 13 to 18 (questionnaire 3 and 6).

Repeated Measures analysis, with the adaptation score from the six questionnaires as the within-subjects factor, showed a significant difference between experienced and novice drivers ($F_{1,400} = 10.25$; $p < .01$; $\eta^2_P = .03$). Experienced drivers performed significantly better on the Adaptation Test during the two years of the study. However, the expected effect, that experienced drivers remained at the same level while the novice drivers improved their performance on the Adaptation Test, was not found. Repeated Measures analysis showed that both groups

significantly improved their performance on the test ($F_{5,1881} = 23.89$; $p < .001$; $\eta_P^2 = .06$), but no interaction effect between experience level and time was found.

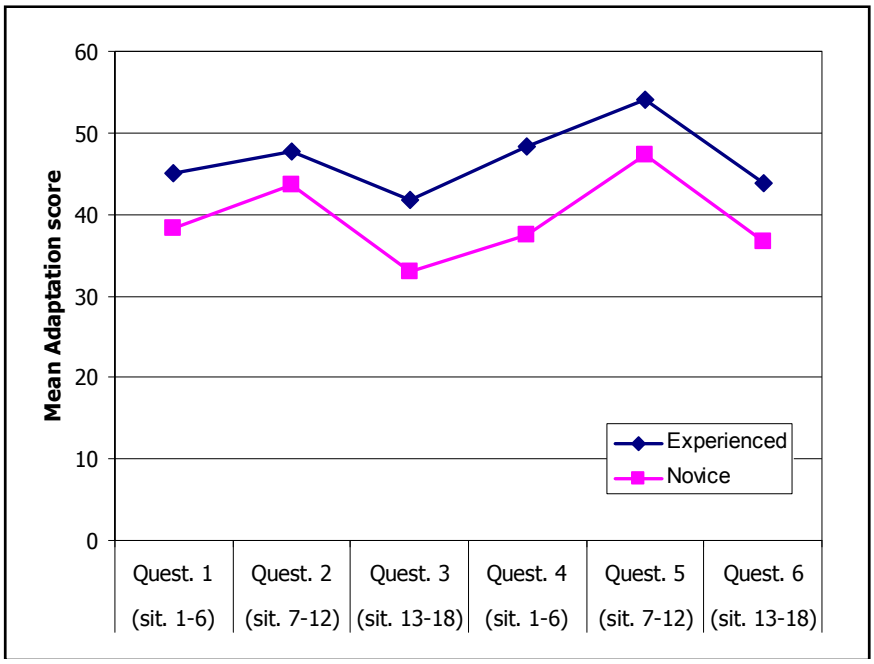

Figure 2. Development of mean adaptation score for experienced and novice drivers in two years

DISCUSSION

The objective of this study was to (further) evaluate a new methodology, using traffic situations depicted in photographs, to measure adaptation of driving speed (the Adaptation Test). A previous evaluation (De Craen et al., 2008) already indicated that the Adaptation Test is effective at measuring adaptation of driving speed to the situation; and that novice drivers performed worse on the Adaptation Test (i.e. less often reported a lower speed in the more complex situation) than experienced drivers. In addition, unsafe drivers and overconfident drivers, as identified in the on-road driving assessment, performed worse on the Adaptation Test.

The new results reported in this paper are somewhat confusing. Ideally we would have expected a relation between the Adaptation Test and self-reported crashes; with lower scores on the Adaptation Test correlating with more crashes. However, there was no such correlation found. A closer look at the reported crashes revealed that these mostly concern minor crashes (e.g. a fender bender on a parking place). It is possible that these crashes were caused by poor vehicle handling skills, while the Adaptation Test measures a higher-order-skill: adaptation of speed to the traffic situation. Nevertheless, this is only speculating. It is impossible to assess in hindsight whether the reported crash was either caused by poor vehicle handling skills, or for example that the driver lost control over the car because of a wrong speed choice.

The new results also showed the development of performance on the Adaptation Test over time. It was expected that experienced drivers would perform better on the Adaptation Test. This was indeed found in the first evaluation of the Adaptation Test. Furthermore, we expected that novice

drivers would improve their performance over time to approach this level. The results did not show this effect. Although the novice drivers improved their performance on the Adaptation Test, the experienced drivers improved just as much. An explanation for the improvement in both groups of drivers could be a selective drop-out of participants in the study. From the total of 607 participants who started the study, only 527 filled out the last questionnaire. It is possible that the participants who dropped out performed relatively bad on the Adaptation Test, resulting in a higher group score for the participants still in the study. The analysis of drop-outs is beyond the scope of this paper, but will be looked at in a later stage.

To sum up, the results of the present study are somewhat confusing. The previous evaluation (De Craen et al., 2008) indicated that the Adaptation Test seemed to measure what it was supposed to measure. The expected differences between groups were small, but consistent. However, the results of the present study suggest that there is no relation with self-reported crashes, and that the performance of the novice drivers on the Adaptation Test does not improve more than the performance of the experienced drivers. Currently, we are still analysing all the data collected in this longitudinal study. So it is too early for clear conclusions about the value of the Adaptation Test. Further analysis of data (e.g. analysis of drop-outs) will have to shed more light on the suitability of the Adaptation Test to measure adaptation.

With respect to further research into the Adaptation Test, we are currently planning an experiment in which participants take the test while wearing an eye-tracking device. This experiment will provide more information on where the participants focus their attention during the test, and if they indeed notice the small differences between the photographs.

REFERENCES

Brown, I.D. & Groeger, J.A. (1988). Risk perception and decision taking during the transition between novice and experienced driver status. *Ergonomics, 31*(4), 585-597.

De Craen, S., Twisk, D.A.M., Hagenzieker, M.P., Elffers, H., & Brookhuis, K.A. (2008). The development of a method to measure speed adaptation to traffic complexity: Identifying novice, unsafe, and overconfident drivers. *Accident Analysis & Prevention, 40*(4), 1524-1530.

Fuller, R. (2005). Towards a general theory of driver behaviour. *Accident Analysis & Prevention, 27*(3), 461-472.

Gregersen, N.P. (1995). *Prevention of road accidents among young novice car drivers*. Doctoral dissertation, Linköping University, Linköping, Sweden.

Kuiken, M.J. & Twisk, D.A.M. (2001). *Safe driving and the training of calibration* (Report no. R-2001-29). Leidschendam, the Netherlands: SWOV Institute for Road Safety Research.

Quimby, A.R. & Watts, G.R. (1981). *Human factors and driving performance* (Laboratory Report 1004). Crowthorne, Berkshire: Transport and Road Research Laboratory.