

NOTES

Learning to Drive: Learners' Self-Reported Cognitive Failure Level Predicts Driving Instructor's Observation Rating of Driving Performance

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Objectives. Evidence increases that cognitive failure may be used to screen for drivers at risk. Until now, most studies have relied on driving learners. This exploratory pilot study examines self-report of cognitive failure in driving beginners and error during real driving as observed by driving instructors. **Methods.** Forty-two driving learners of 14 driving instructors filled out a work-related cognitive failure questionnaire. Driving instructors observed driving errors during the next driving lesson. In multiple linear regression analysis, driving errors were regressed on cognitive failure with the number of driving lessons as an estimator of driving experience controlled. **Results.** Higher cognitive failure predicted more driving errors ($p < .01$) when age, gender and driving experience were controlled in analysis. **Conclusions.** Cognitive failure was significantly associated with observed driving errors. Systematic research on cognitive failure in driving beginners is recommended.

young drivers cognitive failure conscientiousness traffic safety

INTRODUCTION

Driving beginners are at special risk for road accidents [1]. Evidence for psychological predictors of errors that are related to accidents included cognitive function [2, 3]. Thus, tests of cognitive function including self-report questionnaires that assess cognitive function were recommended to screen for drivers at risk [4]. Cognitive failures address function of memory, attention, and task execution. The most frequent class of errors that could endanger driving is procedural errors, i.e., errors that occur in the execution of a routine procedure. These errors are, in Reason's terminology, "skill-based" [5]. Reason called them "slips", i.e., "errors which result from some failures in the execution and/or storage stage of an

action sequence" (p. 9) [5]. "Slips" and also "lapses" include "failure to make an attentional check" (p. 60) and "failure to monitor the current intention" (p. 61). Error theories suggest these failures in part to be situational conditioned but also to result from individual trait-like cognitive failure proneness [6]. These differences in error proneness as a consequence of stable individual difference in self-regulation are most obvious in stressful situations [6, 7]. Heritability estimates of cognitive failure ~50% were reported from a study on monozygotic and dizygotic twins [8]. So far, evidence on the usefulness of cognitive failure to screen for drivers at risk is based on few studies [9]. To our knowledge, no study explored whether cognitive failure and driving performance were related in driving learners. Previous

research that tried to predict instructor ratings of driving errors and violations by self-reported attitudes towards driving and self-efficacy showed a complete lack of association [10]. If cognitive failure is found to be a more valid predictor of instructor error ratings than constructs explored before, early consideration of cognitive failure by driving instructors, e.g., embedded in metacognitive skill training may have preventive value [11]. Hence, this explorative field study explored the association between cognitive failure and driving performance in driving learners. We expected individual differences in cognitive failures to correspond with observed driving errors within driving lessons. The primary goal of the pilot study was to increase familiarity with facets of the driving learning situation and to understand the setting before more rigorous designs are done. Thereby, one aim of the pilot study was to prevent bias in estimates of association. In correspondence analysis, it is generally good to have data that do not come from the same source. Even more in an exploratory pilot study that has limitations and restrictions with respect to control of third variables and sampling, it is beneficial to avoid common-method variance by collecting data from different sources. In collecting data from the same source, the problem is a tendency to make them consistent with each other “irrespective of how unconsciously the respondent does that” (p. 59) [12]. Individuals that perceive higher own level of cognitive failure may just from report more errors during driving because of this tendency of consistent responding. When driving errors and cognitive failure are both assessed by self-report, questionnaire association would be overestimated [13]. Beside common-method variance, there were additional reasons to assess driving performance by instructor ratings instead of self-reports of driving learners. Driving learners may simply be cognitively overstrained to notice and retain their driving performance. Thereby, memory for near-accidents as indicators of driving performance is generally poor. Chapman and Underwood compared near-accident reports and recalls of over 7000 car journeys from 80 subjects over the course of a year [14]. These included over 400 reports or recalls of near-accidents. Chapman and Underwood concluded that

near-accidents were generally forgotten extremely rapidly, with an estimated 80% of incidents being no longer reported after a delay of some weeks. Moreover, there is a well documented tendency to overestimate own driving performance when the assessment makes any reference to the performance of other drivers [15] and interpersonal comparison is likely to influence self-reports in a driving school setting. Self-report measuring of driving performance in the setting of driving schools may also suffer from specific setting related bias: Lajunen and Summala showed impression management to influence self-reported driving performance when the self-report questionnaire was filled out at the driving school [16]. Therefore, in this pilot study, driving performance was assessed by instructors’ report. Another aim of an explorative study is statistical control of some potential confounders [12]. Previous research showed self-report of cognitive failure to be higher in women compared to men [8] and to increase with age [17, 18]. Furthermore, gender (females) [19], and age (younger age) [20] have been shown to be associated with higher risk of driving accidents. Therefore, in exploring the associations between cognitive failures and driving errors, we controlled for age and gender. As an estimator of driving experience, the number of driving lessons received so far was also included as a control variable.

METHODS

2.1. Participants

Based on an Internet registry, all 20 instructors that were registered in a Swiss rural area were contacted by phone by the second author. The instructors were informed about the project that was introduced to address individual predictors of driving performance. After explaining the research design, anonymity of all collected data was assured. Fourteen of the 20 driving instructors agreed to participate (participation rate was 70%). Those instructors who did not agree were asked for their reasons. Three instructors made no comment; given reasons were lack of time ($n = 1$), the feeling to be too old for such studies ($n = 1$), and further education that went along with current

specialization in lessons on motorcycles and trucks ($n = 1$).

Out of the 170 driving learners that received the questionnaire, 53 learners returned their questionnaire. The response rate was 31%, i.e., it was low but still in the range of reported response rates when surveys are mailed by mail as shown in a review on response rate in organizational survey research (M 44.7%, SD 21.8) [21]. The number of corresponding observer schemes that were included in the study was reduced to 42 because 3 participants did not agree for use of their driving observation data and 8 participants had to be excluded because driving observations of the first three driving lessons were precluded from analysis. Driving errors in first three driving lessons were considered to stem from excessive situational demands rather than to be a consequence of cognitive failure. The remaining sample of 42 participants consisted of 19 women and 23 men; their mean (SD) age was 19.2 (1.7) years.

2.2. Procedure

The study lasted from October 2010 to January 2011. The 14 driving instructors that agreed to participate in the study were asked how many learners they educated. The total number of driving learners was 170 and thus 170 questionnaires plus observer coding schemes were sent by mail to the driving instructors who distributed them in closed envelope to the driving learners. Each matching questionnaire and observer coding scheme was marked with a random code. The observer coding schemes and the questionnaire for the driving learner was separately enclosed in envelopes each labeled "for use of the instructor" and "for use of the driving learner"; each contained prepaid envelopes for postal return. Accordingly, without forcing the envelopes open that were clearly addressed, instructors did not see the questionnaire for driving learners and driving learners did not know the coding schemes of instructors. Driving learners were instructed to hand the observer scheme to their driving instructors at the start of the next driving lesson. During the driving lesson, the driving instructors filled out the observer scheme and afterwards sent it to the research team using the prepaid envelope.

The research team combined the questionnaires and observer schemes with the help of the random code. Hence, the procedure guaranteed full anonymity of the data. The study was performed in consensus with all requirements defined by the Swiss Society of Psychology, including participants' rights and guarantee of anonymity.

2.3. Design

The study was a cross-sectional correlational field study [12] that relied on nonprobability sampling. The research question was exploratory because so far little has been known about the association of cognitive failure and driving performance in driving learners. The analysis addressed the correspondence of instructor ratings of driving errors and self-reported cognitive failure. The number of driving lessons taken, age, and gender were control variables.

2.4. Materials

2.4.1. Driving error observation scheme

First, the driving instructors had to record how many driving lessons had taken place to assure the driving lesson was not one of the first three. At the same time, the number of driving lessons taken so far was an indicator of driving experience that was controlled in analysis. The observer categories used by driving instructors to code for errors during driving were "other road users missed or noticed too late" (error category 1); "omission of safe driving behaviour (no use of mirrors, no blinking, forgot to fasten seatbelts, etc.)" (error category 2); "overlooked road signs" (error category 3); "no speed control" (error category 4); "not giving way" (error category 5); "distracted by unimportant things" (error category 6); and "wrong use of accelerator, clutch, or break pedal" (error category 7). The sum of total driving errors categories was the dependent variable in regression analysis. Cronbach's α as an indicator of internal consistency was high (.86).

2.4.2. Cognitive failure questionnaire

The workplace cognitive failure scale (WCFS) consisted of 15 items with a 5-point Likert

response format (1 = *never*, 5 = *always*), asking for the frequency of cognitive failure at work tasks (e.g., “forget important telephone numbers”, “do not focus your full attention on work activities”, “say things to others that you did not mean to say”) [22]. The German version of the questionnaire was recently validated [23]. The WCFS included three subscales: failure in memory function, failure in attention regulation, and failure in action execution. Failures in memory function comprise 5 items (e.g., “cannot remember whether you have or have not turned off work equipment”). Failures in attention also included 5 items (e.g., “do not fully listen to instruction”). Failures in action execution also comprised 5 items (e.g., “throw away something you meant to keep (e.g., memos, tools)”). The internal consistency of the total scale (Cronbach’s $\alpha = .87$) and of the subscales memory, attention, and action were satisfactory (Cronbach’s $\alpha = .72, .83, .76$, respectively).

2.5. Data Analysis

In multiple linear regression analysis, the sum of total driving errors was regressed on self-reported cognitive failure. Both variables did not deviate

from the assumption of normal distribution. Age, gender, and number of driving lessons taken were included in the regression model as control variables. While age also did not deviate from the assumption of normal distribution number of driving lessons taken was significantly skewed because of some participants who had taken very many driving lessons. Therefore, number of driving lessons taken was log transformed before they entered the regression model. For all other analyses, SPSS version 11.0 was used; $p < .05$ was considered significant.

2. RESULTS

Among observed driving errors, omission of safe driving behaviour, e.g., no use of mirrors, no blinking, or no fastened seatbelts were most frequent (Table 1). In total, over 16 errors were observed on average per driving lesson and participant. Pearson correlations among study variables showed significant associations between observed driving errors and self-reports of cognitive failure that was most pronounced for cognitive failures in action execution (Table 2).

TABLE 1. Mean Values of Study Variables

Variable	No. of Items	Format	<i>M</i>	<i>SD</i>	Reliability
Observer category					
Total errors recorded by instructors	7	count	16.86	13.21	.86
Category 1	1	count	2.57	1.98	N/A
Category 2	1	count	4.83	4.17	N/A
Category 3	1	count	2.44	2.09	N/A
Category 4	1	count	2.37	2.41	N/A
Category 5	1	count	1.13	1.07	N/A
Category 6	1	count	2.03	2.60	N/A
Category 7	1	count	2.51	2.45	N/A
No. of driving lessons	1	count	15.62	10.13	N/A
No. of driving lessons (log)	1	N/A	2.53	0.70	N/A
Self-report questionnaire					
Total cognitive failure	15	1–5	1.95	0.52	.87
Subscale memory	5	1–5	2.10	0.69	.72
Subscale attention	5	1–5	2.17	0.69	.83
Subscale action	5	1–5	1.59	0.51	.76
Age	19.33	count	19.33	1.73	N/A

Note. Reliability = Cronbach’s α as an estimate of internal consistency; N/A = not applicable; count = open number format.

TABLE 2. Pearson Correlations Among Study Variables

	Sum of total driving errors 1 recorded by driving instructors						
	1	2	3	4	5	6	7
2 Total cognitive failure	.37 <i>p</i> = .015						
3 Subscale memory	.30 <i>p</i> = .510	.86 <i>p</i> = .000					
4 Subscale attention	.26 <i>p</i> = .102	.88 <i>p</i> < .001	.64 <i>p</i> < .001				
5 Subscale action	.38 <i>p</i> = .012	.72 <i>p</i> < .001	.42 <i>p</i> = .005	.47 <i>p</i> = .002			
6 Number of driving lessons taken (log)	-.12 <i>p</i> = .458	-.03 <i>p</i> = .838	-.08 <i>p</i> = .607	.02 <i>p</i> = .912	-.01 <i>p</i> = .965		
7 Gender	-.19 <i>p</i> = .224	-.01 <i>p</i> = .975	-.15 <i>p</i> = .359	.04 <i>p</i> = .787	.12 <i>p</i> = .433	.03 <i>p</i> = .832	
8 Age	.10 <i>p</i> = .526	-.12 <i>p</i> = .438	-.20 <i>p</i> = .199	-.10 <i>p</i> = .537	.03 <i>p</i> = .856	.25 <i>p</i> = .118	.10 <i>p</i> = .519

Notes. Gender: male = 1, female = 2.

In accordance with the expectation of self-reported cognitive failure to predict observed driving errors when age, gender, and driving experience were controlled, cognitive failure showed a significant positive standardized regression coefficient ($\beta = .39$, $p = .011$; Table 3). Twenty-two percent of variation in observed driving errors was explained, 14.4% of variation was uniquely explained by self-reported cognitive failure. The effect size of self-reported failure in predicting observed driving errors was $f^2 = .17$, which was moderate [24].

3. DISCUSSION

Self-reported cognitive failure predicted instructor ratings of driving performance. Unlike most previous investigations, this field study did not rely solely on questionnaire data and, therefore, the association found was not overestimated because of common-method variance [12, 13]. Observation of driving performance by instructors also excluded bias from poor memory for driving errors in drivers [14]. The results showed that the link between cognitive failure and driving errors in self-reported data on cognitive failure and driving errors that was reported before in professional taxi drivers [4] cannot be explained as an artefact from self-report bias. The preliminary

findings, therefore, add important knowledge to previous attempts that failed to predict instructor ratings of driving errors and violations by self-reported attitudes and self-efficacy [10].

The size of association between self-reports of cognitive failure and ratings of driving performance was moderate in effect size. The unique association between both variables, which was controlled for age, gender, and driving experience, explained 17% of variation in driving performance. Given the other factors that may relate to driving performance including many situational characteristics like quantitative and qualitative task demands, task novelty and difficulty (e.g., parallel parking), environmental factors like traffic volume, the unique association of cognitive failure and driving errors is satisfying. Although the sample size of the study was smaller than intended at the beginning of the study, the post-hoc calculation of power yielded a level of .74 that can be considered to equal the recommended convention of .80 [24].

3.1. Limitations

The study, however, also has many limitations. First, the design is only correlational and cannot provide any causal explanation. Second, the non-probability sampling limits the generalizability of results. Third, the exploratory study suffered from

TABLE 3. Regression of Observed Driving Errors on Self-Reported Cognitive Failure

Predictor Variables	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>p</i>
Gender	-5.40	3.82	-.21	-1.41	.17
Age	1.57	1.15	.21	1.36	.18
No. of driving lessons taken (log)	-2.79	2.81	-.15	-0.99	.33
Total cognitive failure	9.96	3.71	.39	2.68	.01

Notes. *N* = 42; dependent variable = sum of total driving errors recorded by driving instructors; $F^2 = .22$, adjusted $F^2 = .15$; *B* = unstandardized regression coefficient; *SE* = standard error in estimation of unstandardized regression coefficient; β = standardized regression coefficient; *t* = test of β to differ significantly from zero.

a high percentage of nonresponse persons whose characteristics might have biased the association found. In total, the results are preliminary and should be replicated in prospective research including a larger sample, probability sampling, and analysis of nonresponse.

3.2. Conclusions

Cognitive failure was associated with driving errors that were rated by driving instructors. Preliminary findings of this pilot study showed cognitive failure to be a candidate intervening variable in research on road safety of novice drivers. In stressful driving situations, which novice drivers frequently experience, high proneness to cognitive failures may be a special risk. Research on driving education that refers to cognitive failure by teaching good perceptual heuristics [25] and addresses cognitive fallacies during driving seems promising.

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