Is past behavior the best predictor of future behavior? Comparing the behavioral validity of self-reported speeding and driving simulator data

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***Abstract*—While there are several different factors that contribute to traffic accidents, speeding certainly seems to be one of the more prominent ones. Previous studies have found a strong relationship between speeding and accident risk, with higher speed generally increasing accident propensity. However, there is still no consensus on the best way of measuring speeding behavior. Previous research has utilized various sources of speeding data, such as self-report measures and driving simulators, with each of these sources having their own limitations. In the present study, we explored the behavioral validity of three different assessment methods of speeding – 1) a direct self-report measure (self-reported speeding violations), 2) an indirect self-report measure (self-reported speeding norms), and 3) an objective measure (driving simulator). On a sample of 46 participants, we found that, regardless of the assessment method, traffic offenders exhibited somewhat higher levels of speeding than non-offenders. However, the difference was significant only in the case of the direct self-report measure. Hence, our results suggest that self-reported speeding violations show higher behavioral validity than the other two methods. In the discussion, we offer some ideas that could improve driving simulators and simulator-based studies and contribute to better behavioral validity of such data.**

I. MOTIVATION

Undoubtedly, speeding represents one of the main causes of traffic accidents all over the world [1]. When driving at a very high speed, control over vehicle handling is decreased and the potential for a fatal traffic accident is increased [2]. A first step in improving traffic safety and decreasing speeding-related accidents is to accurately assess speeding and, in turn, tailor interventions to individuals "at risk." However, obtaining a valid measure of speeding behavior is challenging. Most frequently, self-reports of speeding are utilized to assess speeding in various driving contexts. In general, they have been found to positively correlate with speeding violations. However, they frequently underrepresent actual behavior [3].

In the light of technological advances, driving simulators were introduced as an objective measure of speeding. They are less prone to drivers' biases (e.g., social desirability effects) and provide an accurate representation of the vehicle and driving environment [4]. Nevertheless, driving simulators do not always elicit the same responses as real-life situations [5]. Technological limitations, simulator sickness, and limited complexity of the social context of driving have been discussed as potential limitations [6]. In fact, authors have argued that people known to the driver (e.g., family members) and people unknown to the driver influence individuals' speeding behaviors in various ways [7]. For instance, the direct exposure to others' driving behavior as well as their values and norms directly relate to individual driving. The information about close others' driving behavior may also be used as an indicator of individual driving [8], yet this approach is rather underutilized.

II. RESEARCH QUESTIONS

The direct (i.e., self-reports), indirect (i.e., self-reported information about close others), and objective assessment (i.e., simulator data) each have advantages and drawbacks. To date, therefore, none of these approaches can be recommended over the other when assessing speeding. Therefore, the present contribution is aimed at exploring the behavioral validity of three assessment methods of speeding (direct, indirect, and objective). Behavioral validity refers to how well an assessment of a driving parameter reproduces results which would also occur on the road [9].

Based on this, we wanted to test whether those who reported traffic violations, differ in their self-reports of speeding and objective performance in the simulator from those who did not commit traffic violations. As it is assumed that actual driving behavior (assessed in a

TABLE I.
DESCRIPTIVE STATISTICS, CORRELATIONS AND RELIABILITIES

	M	*SD*	1	2	3	4	5	6	7
1. Gender	–	–	–						
2. Age	30.13	10.16	-.08	–					
3. Annual mileage (km)	168.87	156.82	-.25	.38**	–				
4. Speeding: Direct assessment	2.59	0.73	-.14	-.02	.26	.84			
5. Speeding: Indirect assessment	2.57	0.81	.10	-.29	-.29	.38*	.68		
6. Speeding: Objective assessment	2.33	1.93	-.23	-.14	-.09	.17	.07	–	
7. Violations	–	–	-.08	.22	-.03	-.33*	-.05	-.15	–

Note. Violations were coded 1 = at least one violation, 2 = no violations. Cronbach alpha reliabilities are shown in the diagonal. * $p < .05$, ** $p < .01$, *** $p < .001$.

simulator) is a better predictor of future behavior (e.g., [10]), we assumed that simulator data of speeding would best discriminate offenders from non-offenders. In this way, the study contributes to the understanding of how well direct, indirect, and objective assessments are aligned with real-life outcomes associated with driving.

III. METHODOLOGY

The behavioral validity of each of the three methods was explored using a sample of 50 drivers' license holders who filled-out a series of questionnaires and drove in a simulator. Due to simulator sickness and other exclusion criteria, the final sample consisted of 46 participants, 56.6 % of which were female. Average age was 30.13 years (*SD* = 10.16). About a quarter of participants (23.9 %) reported committing at least one violation in the past year. Most participants (92 %) used their car at least a few times a week.

Direct speeding assessments were obtained using the questionnaire of risk behavior in traffic by Iversen and Rundmo [11]. The six items reflected speeding violations (e.g., "*How often did you break 50 kmph speed limits by more than 10 kmph*?") and included a 5-point response format (1 = *never* to 5 = *very often*). Indirect speeding assessments were measured using a self-constructed scale where participants indicated to what extent they agreed with statements like "*Most people I care about do not speed*" (reverse coded) on a 5-point scale (1 = *strongly disagree* to 5 = *strongly agree*). Objective speeding data were obtained using the NERVteh driving simulator [12], which includes a motion platform, superior degree of movements, and algorithms for interpreting motion data (e.g., acceleration, breaking etc.). Participants were asked to drive in four different scenarios (city-easy, city-difficult, highway-easy, highway-difficult) for approximately 25 minutes. Speeding in the simulator was assessed using the extent to which the speed limits were broken based on the Slovenian legislation when driving in a city environment or on a highway.

IV. SOLUTION AND DISCUSSION

Tables I and II provide the preliminary results. As shown in Table I, the amount of violations significantly and inversely correlated only with direct assessments of speeding. More precisely, participants who reported more violations had higher scores on self-reported speeding violations.

A similar result is evident from Table II which shows differences in scores, obtained from different speeding assessments. Offenders exhibited more risk behavior in terms of speeding than non-offenders which is also in line with previous literature (e.g., [6]). Apparently, the direct assessment exhibits some level of behavioral validity. Indirect assessments of speeding did not discriminate between the two groups, indicating that "who your friends are" does not tell much about who you are in terms of speeding. As this approach to speeding assessment is rather rare, future studies should continue to explore the utility and validity of indirect assessments. Contrary to expectations, offenders and non-offenders did not differ in objective assessments of speeding. The differences were not statistically significant and were also associated with a small effect size (Cohen's *d*).

These findings are actually somewhat in line with previous criticism of simulator data. For instance, Carsten and Jamson [4] pointed out that simulator data are more predictive of actual driving performance (i.e., driving skills and reaction times in real-driving contexts) than driving behavior such as speeding (i.e., the way

TABLE II.
DIFFERENCES BETWEEN OFFENDERS AND NON-OFFENDERS IN SPEEDING ASSESSMENTS

	At least one violation (*N* = 11)		No violations (*N* = 35)				
	M	*SD*	*M*	*SD*	*t*	*p*	Cohen's *d*
Speeding: Direct assessment	3.02	0.50	2.47	0.75	2.29	.027*	0.86
Speeding: Indirect assessment	2.64	0.74	2.54	0.84	0.33	.744	0.13
Speeding: Objective assessment	2.83	1.85	2.17	1.95	0.99	.327	0.35

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

some choses to drive, one's habitual style of driving). However, it would be premature to conclude that simulator data do not show behavioral validity based on our data and that they cannot be used in the context of speeding. Our results should be rather used to improve driving simulators and simulator-based studies. For instance, prolonged driving (e.g., more than one hour) may bear a greater potential to elicit similar responses and habits as real-life situations. Also, simulator-based studies should take better account of the social context of driving by, for instance, including other persons in the passenger seat at least during one part of the experiment [5]. Taken together, direct self-reports of speeding show higher behavioral validity than the other two methods. Improvements of research simulator-based research designs, however, can potentially yield more valid results. Future studies should continue to contrast and compare different assessments of speeding and other risk behaviors (e.g., distracted driving).

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