Toward Developing Bicycle Rider Behavior Questionnaire (BRBQ)

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1 INTRODUCTION

A relatively large body of studies have shown that human factors have a critical role in traffic crashes, and bicycle crashes are not an exception. In the eyes of other road users, bicyclists often manifest unexpected behaviors and fail to obey traffic rules which could result in higher crash rates among road users [1, 2]. This study aims to investigate the aberrant behaviors of bicyclists and their relation to crash risk. Research of this type originally owes to the taxonomy of human error by Reason et al. [3]. Over the years this approach was further developed through other researchers' work. The research body, however, has mostly been concentrated on the application of already validated instruments (e.g. [4-6]), rather than validation studies. To date, the studies have attempted to develop and validate behavior questionnaires for driving [5], walking [7] and motorcycle riding [8]. The most common identified type of behaviors were errors and violations. Researchers defined errors as "failure of planned actions to achieve their intended consequences" and violations as "deliberate deviations from those practices believed necessary to maintain the safe operation of a potentially hazardous system" [3]. To the best of our knowledge, there have been no attempts at establishing a validated questionnaire for cyclists' behavior. Application of a taxonomy of human error would be an important complement to the current literature of bicycle safety and provides an important contribution.

2 METHOD

The 39-item questionnaire was developed partly based on the Motorcycle Riding Behavior Questionnaire and original Driver Behavior Questionnaire [3, 8], but a number of modifications were conducted to reflect bicyclist behavior. Moreover, items were also added based on the available literature and traffic rules related to cyclists. The respondents were asked to report how often they performed each aberrant behavior (i.e., items presented in Table 1) on a five-point Likert scale (1: never, 5: nearly all the time). After conducting a pilot and primary analysis of 100 respondents, the questionnaire was revised. This changes led to a 34-item Bicycle Riding Behavior Questionnaire. An online version of the questionnaire was distributed among a convenience sample from amateur, semi-professional, and professional bicycle clubs in Iran. The respondents have been further asked to report the number of crashes, each crash severity and at-fault state of the crash in the last three-years period and the period before that.

2.1 Sample

Among an unknown number of visits to the invitation letter, 771 clicks on the link were registered. A total of 306 (72 females; 234 males) respondents filled out the questionnaire, which reflects a 40 percent response rate. The respondents' average age was 33.1 years (range 16-72, SD=10.0) with 10.2 years of riding experience (range: 1-39, SD=9.4), and 9.1 hours per week (range: 1-25, SD=7.2). A total of 21.4% of the respondents had a graduate degree, 46.5% had an undergraduate degree and the rest (33.1%) had a high school degree or less. Respondents rode mainly in urban and suburban areas (71%), intercity roads (15%), and mountain or desert areas (14%). 56% of the respondents experienced at least one bicycle crash (M= 1.64, SD=2.15). In addition, 36% of the respondents indicated that they had been involved in at least one at-fault crash (M= 0.84, SD= 1.50).

Table 1: PCA with Varimax Rotation of the BRBQ

	Dimensions				
Items	**1**	**2**	**3**	**4**	**5**
7. Speed up to beat the traffic light turning red	.701				
30. Ride in prohibited expressways, drives, highways, interstate routes, bridges, and thruways unless authorized by signs	.653				
8. Run red lights	.635				
15. Become angered by another road user and indicate your hostility by whatever means you can	.614				
13. Have felt frustrated by other road users	.608				
14. Felt angry and aggressive towards another road user	.601				
6. When riding at the same speed as other traffic, you find it difficult to stop in time when a traffic light has turned against you	.575				
29. Not using bicycle dedicated lane (when they are available)	.515				
27. Drive in the opposite direction of traffic flow	.505		.390		
28. Do not yield to pedestrians	.491		.368		
12. Riding so close to the vehicle in front of you that it is hard to stop in an emergency	.429	.352			
37. Riding without having at least one hand on handlebars at all times		.774			
16. Talk on the phone while riding your bike		.743			
23. Attempt wheelies		.686			
17. Send texts while riding your bike		.669			
10. Get involved in unofficial races with other riders or drivers		.636			
19. Listen to music while riding		.526			
22. Hard to maintain balance at low speeds			.772		
26. Have difficulty controlling your bicycle downhill			.732		
20. Do not know which gear to use			.654		
21. Have skid on a wet road or manhole cover			.513		
25. Almost lost control due to obstacle presence in road surface			.495		
2. Fail to notice someone stepping out from behind a parked vehicle until it is nearly too late				.794	
1. Fail to notice that pedestrians are crossing the street when you are turning				.761	
3. Fail to notice a pedestrian waiting to cross at a crosswalk				.685	
5. Been distracted or pre-occupied to the point that you did not that the vehicle in front of you slowed and you had to brake hard to avoid a collision				.672	
4. Miss yield signs and narrowly avoid colliding with traffic that has the right of way				.409	
32. Fail to give hand signals (at least two seconds preceding the beginning of the movement) for left and right turns					.812
33. Fail to give appropriate signal for stopping the bicycle					.765
34. Fail to give an audible signal when overtaking pedestrians					.746

RESULTS

Principal Component Analysis with Varimax Rotation was used to extract dimensions' structure of BRBQ. The five-dimension solution which explained 51% of the total variance was extracted (Table 1). The dimensions were termed: "Stunts and Distractions", "Traffic Violations", "Notice Failures", "Control Errors", and "Signaling Violations" with Cronbach's alpha ranging from 0.70 to 0.84. The distinction between intentional violations (i.e., stunts and distractions, Traffic Violations and Signaling Violations) and unintentional errors (i.e. attention errors and Control Errors) is consistent with the original theoretical taxonomy of human errors.

Kruskal Wallis Test results showed that bicycling experience failed to exert any significant influences on the BRBQ means for the Notice Failures (χ^2(31) = 39.7, p = 0.135) and Traffic Violations (χ^2 (31) = 30.61, p = 0.486). Yet, as riders gain more experiences frequency of Signaling Violations increased (χ^2 (31) = 53.1, p = 0.008); while their stunts and distraction (χ^2 (31) = 47.8, p = 0.22) and Control Errors (χ^2 (31) = 48.9, p = 0.022) declined. As riders' education increased, the stunts and distraction dimension (χ^2 (5) = 32.2, p = 0.000) as well as the Traffic Violations (χ^2 (5) = 11.1, p = 0.049), and Control Errors dimension (χ^2 (5) = 24.0, p = 0.000) declined.

Table 2 shows the results of binary logistic regression models for predicting at-fault self-reported crashes (1= reported crash; 0= otherwise). Estimated model had a pseudo R-square values of 0.11. Riding experience (β = -0.036, p < 0.002) and history of crashes (β = 0.945, p < 0.000) were the significant predictors of self-reported crashes in both models. More importantly, Traffic Violations (β = 0.587, p < 0.000), Stunts and Distractions (β = 0.27, p < 0.050), and Signal Violations (β = -0.25, p < 0.004) were the predictor of at-fault self-reported crashes.
Given that bicyclists were in an at-fault state in more than half of their self-reported crashes and the relationship between aberrant behavior and crash risk, we conclude that bicyclists and policy makers should develop behavioral norms and supportive infrastructure and regulatory systems that discourage aberrant behavior.

Table 2: Predictors of reported at-fault crashes (1= reported crash; 0= otherwise)

Variable	Coef.	Std. Err.	z	P>z
Dimension 1) Traffic Violations	0.587	0.162	3.620	0.000
Dimension 2) Stunts and Distractions Violations	0.250	0.127	1.960	0.005
Dimension 3) Control Errors	0.141	0.173	0.810	0.415
Dimension 4) Notice Failures	-0.226	0.156	-1.450	0.146
Dimension 5) Signaling Violations	-0.255	0.091	-2.790	0.005
Riding Experiences	-0.036	0.012	-3.030	0.002
Riding Hours Per Day	0.009	0.015	0.590	0.557
History of Crashes	0.945	0.199	4.750	0.000
Riders` Age	-0.018	0.012	-1.500	0.133
Education Level	0.198	0.080	2.480	0.013
Gender (1= Male)	0.178	0.234	0.760	0.447
Professional Bicyclist	0.358	0.301	1.190	0.235
Constant	-1.793	0.626	-2.860	0.004

2.2 References

1. Wegman, F., F. Zhang, and A. Dijkstra, How to make more cycling good for road safety? Accident Analysis & Prevention, 2012. 44(1): p. 19-29.
2. Langford, B.C., J. Chen, and C.R. Cherry, Risky riding: Naturalistic methods comparing safety behavior from conventional bicycle riders and electric bike riders. Accident Analysis & Prevention, 2015. 82: p. 220-226.
3. Reason, J., et al., Errors and violations on the roads: a real distinction? Ergonomics, 1990. 33(10-11): p. 1315-1332.
4. Shi, J., et al., Aberrant driving behaviors: A study of drivers in Beijing. Accident Analysis & Prevention, 2010. 42(4): p. 1031-1040.
5. Nordfjærn, T., A.M. Hezaveh, and A.R. Mamdoohi, An analysis of reported driver behaviour in samples of domestic and expatriate Iranians. Journal of Risk Research, 2015. 18(5): p. 566-580.
6. Hezaveh, A.M., et al., Predictors of Crash Among Iranian Drivers; An Exploratory Analysis of Developed Driver Behavior Questionnaire. 2017.
7. Granié, M.-A., M. Pannetier, and L. Guého, Developing a self-reporting method to measure pedestrian behaviors at all ages. Accident Analysis & Prevention, 2013. 50: p. 830-839.
8. Elliott, M.A., C.J. Baughan, and B.F. Sexton, Errors and violations in relation to motorcyclists' crash risk. Accident Analysis & Prevention, 2007. 39(3): p. 491-499.