



Evaluating pedestrian behavior at crosswalks: Validation of a pedestrian behavior questionnaire for the U.S. population



Shuchisnigdha Deb^{a,*}, Lesley Strawderman^a, Janice DuBien^b, Brian Smith^a, Daniel W. Carruth^c, Teena M. Garrison^c

^a Department of Industrial & Systems Engineering, Mississippi State University, P.O. Box 9542, Mississippi State, MS, 39762, USA

^b Department of Mathematics and Statistics, Mississippi State University, P.O. Box MA, Mississippi State, MS, 39762, USA

^c Center for Advanced Vehicular Systems, Mississippi State University, P.O. Box 5405, Mississippi State, MS, 39762, USA

ARTICLE INFO

Keywords:

Pedestrian behavior questionnaire (PBQ)

Violation

Error

Lapse

Aggressive behavior

Positive behavior

ABSTRACT

The aim of this study was to develop and validate a self-reporting Pedestrian Behavior Questionnaire (PBQ) for the U.S. population to measure frequency of risky behaviors among pedestrians. The PBQ includes 50 survey items that allow respondents to rate the frequency with which they engage in different types of road-using behaviors as pedestrians. The validation study was conducted on 425 participants (228 males and 197 females) between the ages of 18 and 71. Confirmatory factor analysis differentiated pedestrian behaviors into five factor categories: violations, errors, lapses, aggressive behaviors, and positive behaviors. A short version of the PBQ with 20 items was also created by selecting four items with high factor loadings from each of the five factor categories. Regression analyses investigated associations with scenario-based survey behavioral responses to validate the five-factor PBQ subscale scores and composite score. For both long and short versions, each of these five individual factor scales were found to be reliable ($0.7 < \text{Cronbach's } \alpha < 0.9$) and valid (significant association with $p < 0.0001$), except in the case of positive behaviors ($\alpha < 0.6$) which requires further expansion. The effects of gender and age on the PBQ scores were investigated and found to be consistent with previous research. This PBQ can serve as an instrument of pedestrian self-assessment in educational and training contexts as well as can be useful to all researchers investigating pedestrian safety for all age groups.

1. Introduction

Pedestrian safety is a rising problem across the world. According to the National Highway Traffic Safety Administration (NHTSA), in the United States there were 4884 pedestrian deaths and around 65,000 injuries from traffic crashes during 2014 (NHTSA, 2016). GHSA (2016) reported that there was an estimated 10% increase in pedestrian fatalities due to traffic crashes in the United States in 2015, which is the largest year-to-year increase in the last four decades. The report also states that this is a continuously increasing trend, with pedestrian fatalities now accounting for around 15% of all motor vehicle crash-related deaths.

Previous research on pedestrians have shown that among all types of road-users, pedestrians are the most flexible and can respond most quickly; however, they are also the most unpredictable and cannot be effectively controlled by regulations (Jian et al., 2005; Lavalette et al., 2009). In a report published by the National Highway Traffic Safety Administration (NHTSA, 2008), it was stated that most pedestrian

accidents occur due to their unpredictable behavior. Researchers have also found that most of the problems and accidents occur when the pedestrians do not obey traffic rules (Ward et al., 1996; Zhuang and Wu, 2011), which is a common occurrence. For example, instead of patiently waiting at the curb, most pedestrians would prefer to cross a road in unauthorized places, even if it raises anxiety (Zhuang and Wu, 2011). The authors also reported that two-thirds of pedestrians did not look around for vehicles before crossing the street and 16.1% did not look for an oncoming vehicle even while crossing the street. Among those who observed an approaching vehicle, 40.6% of them stopped, 11.4% stepped back to let the vehicle go by, but 31.9% hurried across anyway. There were many instances where pedestrians used cell phones or listened to music while walking or even crossing roads. Observation also revealed that pedestrians were often found to be so engrossed in conversation with their companion that they unintentionally violated the rules or forgot to look for vehicles while crossing a road. Therefore, it is important to understand the underlying pedestrian behavior causing these incidents so that transportation boards can implement the

* Corresponding author.

E-mail address: sd1278@msstate.edu (S. Deb).

proper combination of engineering, education and enforcement to counteract this troubling trend.

Unlike the research tools available for risky driving behavior, agreed upon frameworks for investigating pedestrian behavior are rare. Recently, however, Granié et al. (2013) developed one of the most complete questionnaires, the self-report Pedestrian Behavior Scale (PBS). PBS was developed and validated in France and was utilized in Greece as well (Papadimitriou et al., 2016). The original PBS included survey items for five different types of pedestrian behavior: violations, errors, lapses, aggressive behaviors, and positive behaviors. In France, these five types of behaviors were combined into four components: *transgressions* (violations and errors), *lapses*, *aggressive behaviors*, and *positive behaviors*. In Greece, the researchers grouped pedestrian crossing behaviors into three components: *risk-taking and optimization* (violations, errors, aggressive behaviors, and lapses), *conservative* (positive behaviors), and *pedestrian for pleasure* (filter items included in the results). Until now, this tool has not been validated for the U.S. population, even though it is the most complete questionnaire available for gaining a more detailed understanding of risky behaviors among pedestrians of all ages. This study proposed a framework for pedestrian research by validating the French PBS for the U.S. population as an aid to understanding the kinds of behaviors that lead pedestrians to collisions and injuries in this country. The researchers of this study used the terms “Pedestrian Behavior Questionnaire (PBQ)” for that framework. The validation of the questionnaire was performed using a confirmatory factor analysis to compare the factor structure with previously validated models (Granié et al., 2013; Papadimitriou et al., 2016) as well as with a five-factor model (violations, errors, lapses, aggressive behaviors, and positive behaviors). The Researchers also compared the scale score with pedestrians’ intended behaviors on the road, collected from five different scenario-based survey responses.

2. Related work

2.1. Pedestrian behavior

Under everyday traffic conditions, pedestrians display a rich variety of self-organized behaviors. Since pedestrians are the most vulnerable road-users in pedestrian-vehicle collisions, their safety is of great concern for transportation researchers. Studies in the past have examined pedestrian behaviors, including walking speed (Fitzpatrick et al., 2007; Manual, 2010); zone of comfort, defined as the accepted gap from other road users or objects (Meng and Kang, 2015; Wang et al., 2010); and trip purpose and route choice (Lavalette et al., 2009; Robin et al., 2009; Hoogendoorn and Bovy, 2004). These studies considered pedestrian behavior in many situations, not only crossing streets. Factors which were found to be significant in pedestrian behavior research include structural factors (road design, traffic-sign and signal design, traffic density); environmental factors (speed limit, vehicle type, population density, time of day, weather conditions); and human factors, for both

drivers and pedestrians (decision-making errors, alcohol level, age, lack of proper education, and personality) (NHTSA, 2013).

According to the NHTSA (2008) report, almost three-fourths (73%) of the pedestrian fatalities in the U.S. occur in urban settings versus rural settings. Over two-thirds (70%) of the pedestrian fatalities occur at non-intersections versus at intersections. Eighty-nine percent of the pedestrian fatalities occur during normal weather conditions (clear/cloudy), not during rain, snow or fog conditions, although 70% of the fatalities occur during the nighttime (6:00 p.m.–5:59 a.m.) (U.S. Department of Transportation, 2014). Hamed (2001) stated that those pedestrians who had been involved in a traffic crash were less likely to take risks by violating rules thereafter. On the other hand, as reported by Xu et al. (2013), if a pedestrian crosses the road at an unauthorized place and has a successful experience in violating the traffic law, s/he is likely to repeat this offense at the same location. Koh and Wong (2014) found that a person would be more likely to violate the traffic rules on a 4-lane road with a wide median rather than on a 6- or 7-lane road, and as an individual rather than with companions. Mitman et al. (2008) discovered that pedestrians at unmarked crosswalks prefer to look both ways before crossing, to wait for larger gaps, and then to run. Zhuang and Wu (2011) stated that middle-aged jaywalkers in urban cities are less likely to be involved in a crash when they cross in a group. Because of their flexibility and ability to respond quickly, pedestrians generally make faster decisions and experience smaller waiting times compared to other road users; however, this also increases road accident risk exposure (Grayson, 1987).

All of the research discussed above was performed using observational studies or historical data. However, this research approach is not comprehensive; it is not possible to collect every type of pedestrian behavior under all possible risky situations through observation. In addition, research boards would not approve putting pedestrians in unsafe road scenarios for experimental studies. In order to investigate risky behaviors, many researchers have proposed behavior questionnaires for different road users (drivers, bicyclists, motorcyclists, and pedestrians), as a low-cost, safer, and more comprehensive mode of collecting data (Papadimitriou et al., 2016; Özkan and Lajunen, 2005; Aberg and Rimmo, 1998; Lawton et al., 1997; Reason et al., 1990). These studies have classified road behaviors using several categories. The first differentiation in road-user risky behaviors is made between intentional offenses and unintentional offenses. Intentional offenses can be classified into violations and aggressive behaviors, while unintentional offenses can be classified as lapses and errors. The most frequent behaviors are conservative or positive behaviors. However, sometimes positive behaviors involve the tendency not to minimize crossing time and distance. For example, “I let a car go by, even if I have the right-of-way, if there is no other vehicle behind it” (item P5). These kinds of behaviors can nevertheless confuse and/or annoy vehicle drivers because of pedestrians’ delayed actions and can therefore expose them to risk due to impatient responses from drivers. Definitions of these different road-user behaviors are given in Table 1.

Table 1
Definitions of different types of pedestrian behaviors.

| Pedestrian Behavior | Definition | Example | Reference |
|---------------------|---|--|--|
| Violation | Deliberate deviation from social rules without intention to cause injury or damage. | Not using nearby pedestrian crosswalk to cross | Reason et al. (1990) |
| Error | Deficiency in knowledge of traffic rules and/or in the inferential processes involved in making a decision. | Crossing diagonally to save time | Rasmussen (1980), Reason et al. (1990) |
| Lapse | Unintentional deviation from practices related to a lack of concentration on the task; forgetfulness. | Forgetting to look around for vehicles before crossing | Reason et al. (1990) |
| Aggressive Behavior | A tendency to misinterpret other road users’ behavior resulting in the intention to annoy or endanger. | Getting angry with another user and insulting him | Lawton et al. (1997), Baxter et al. (1990) |
| Positive Behavior | Behavior that seeks to avoid violation or error and/or seeks to ensure traffic rule compliance. | Not crossing diagonally or letting other road users go first | Özkan and Lajunen (2005) |

Download English Version:

<https://daneshyari.com/en/article/4978686>

Download Persian Version:

<https://daneshyari.com/article/4978686>

[Daneshyari.com](https://daneshyari.com)