Pedestrian violations: Reasoned or social reactive? Comparing theory of planned behavior and prototype willingness model

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ABSTRACT

Pedestrians hold high responsibility in accidents because of their unsafe traffic behaviors. Pedestrian violations are an important traffic safety problem, especially in low and middle-income countries. The problem would be better understood and solved by theory-based research on pedestrian violations. The theory of planned behavior (TPB) and the prototype willingness model (PWM) are two leading decision-making frameworks that are applied to a wide range of behaviors. These theories address the reasoned and social reactive components in decision-making. The current study aimed to compare the TPB and the PWM in pedestrian violations using structural equation modeling (SEM). The results revealed that the TPB, the PWM, and the integrative model of the TPB and the PWM were relevant models in understanding pedestrian violations and violation intentions. However, the explanatory power of the PWM and integrative models were higher than the TPB. These findings indicate that pedestrian violations happen mostly in a social reactive way (through willingness) rather than deliberate (intentional) way. Prototype perceptions, willingness, and perceived behavioral control were the most important predictors of pedestrian violations. The findings are discussed in relation to the efficacy of the TPB and the PWM, as well as the theoretical contributions and applied implications for practitioners.

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1. Introduction

Road traffic injuries are one of the leading causes of deaths for the 15–29 age group (World Health Organization, 2015). The World Health Organization (WHO) puts special effort to prioritize the road traffic deaths as a major health problem as more than 1.2 million people die in accidents (WHO, 2015). Twenty-two percent of these fatalities are pedestrians, who are not required to have any specific skill or a license, unlike drivers. Since they do not have any protective equipment around them, the pedestrians are more vulnerable to accidents than car occupants. Despite this fact, the pedestrians contribute a lot to the accidents by violations (Taubman-Ben-Ari & Shay, 2012; Zhou & Horrey, 2010). Therefore, understanding the psychological mechanism behind the pedestrian violations is a pressing issue especially for countries with a young and mobile population.

The researchers' primary interest in the traffic environment was on the driver behaviors, therefore, pedestrian-focused studies are not as much as the driver-focused studies in the literature. Moreover, the existing literature on pedestrian

behaviors is mostly *atheoretical.* On the other hand, some social-psychological theories, such as the theory of planned behavior (TPB), were extensively studied in the pedestrian context (Ajzen, 1991). Over the last 20 years, the TPB was applied to various pedestrian intentions and behaviors. Some of these studies are on violations (e.g., Zhou, Romero, & Qin, 2016), walking when intoxicated (Haque et al., 2012), and distracted walking (Barton, Kologi, & Siron, 2016), in various countries such as UK (Evans & Norman, 1998), Spain (Moyano-Díaz, 2002), and China (Zhou, Horrey, & Yu, 2009).

While the TPB has established an empirical base in pedestrian research, a competing socio-cognitive theory, *the prototype willingness model* (PWM; Gibbons, Gerrard, Blanton, & Russell, 1998), has become a popular theory for understanding a wide range of risky behaviors. Although it provides insight for some road behaviors, such as such as speeding (Elliott et al., 2017), it still awaits to be investigated in pedestrian behaviors. Based on the previous research, the primary aim of the current study is to examine the utility of the TPB, the PWM, and an integrative model that blends TPB and PWM in pedestrian violations.

1.1. Pedestrian violations

The accidents involving pedestrians are not only due to the drivers' errors or violations, but also violations and lapses of pedestrians (Qu, Zhang, Zhao, Zhang, & Ge, 2016). Even when safe routes such as signalized crossings are available, pedestrians tend to use the gaps in traffic (Hamed, 2001) and do mid-block and diagonal crossing to save time and shorten the distance (Baltes, Chu, & Guttenplan, 2003). Although these violations are one of the leading causes of accidents, pedestrian behavior has not been investigated as intensive as the driver behavior (Rosenbloom, Nemrodov, & Barkan, 2004). Therefore, understanding the psychological antecedents of pedestrian behaviors are essential for safer traffic environment.

The pedestrian behavior research that had been an understudied subject among researchers until the early 2000 s recently gained interest (Qu et al., 2016). Over the last two decades, some contextual and personal factors have been determined, such as pedestrian density, attitudes, personality, and demographics (Granié, Pannetier, & Gueho, 2013; Rosenbloom et al., 2004). For instance, younger pedestrians were found to have a higher tendency of violations (Granié et al., 2013), and a more positive attitude toward pedestrian violations than adults' (Moyano-Díaz, 2002). Another demographic variable, gender, is also investigated in the pedestrian context, and it is found that men tend to violate the traffic rules and cross in risky situations more than women (Moyano-Díaz, 2002; Rosenbloom et al., 2004). Moreover, another study conducted in China confirmed men's higher tendency of committing aggressive pedestrian behaviors, and also found that women show a higher frequency of positive behaviors than men (Qu et al., 2016). In addition to these predictors, the violators' attitudes, subjective norms, perceived behavioral control, and intentions were also investigated with the TPB framework.

1.2. The theory of planned behavior

The *theory of planned behavior* (TPB) suggests that the most important predictor of behavior is behavioral intentions. Intentions in this theory reflect a person's readiness to perform a given behavior (Fishbein & Ajzen, 2010), and are predicted by individuals' attitudes toward performing the behavior, subjective norms related to the behavioral performance, and perceived behavioral control over that behavior (see Fig. 1).

Attitudes, in this respect, are the individual's overall favorable or unfavorable evaluation of the behavior. *Subjective norms* are the individual's perception of whether the close others approve or disapprove of performing the behavior (Ajzen & Fishbein, 1980). Finally, the *perceived behavioral control* (PBC), is a combination of perceived control and self-efficacy related to the behavior (Ajzen, 2002; Conner & Sparks, 2005). Control denotes the perceived control over the behavior, whereas self-efficacy is the perception of ease or difficulty of performing the behavior. In the TPB, the PBC is direct determinant of the intention, and it also predicts the behavior to the extent that it accurately reflects the actual control over the behavior.
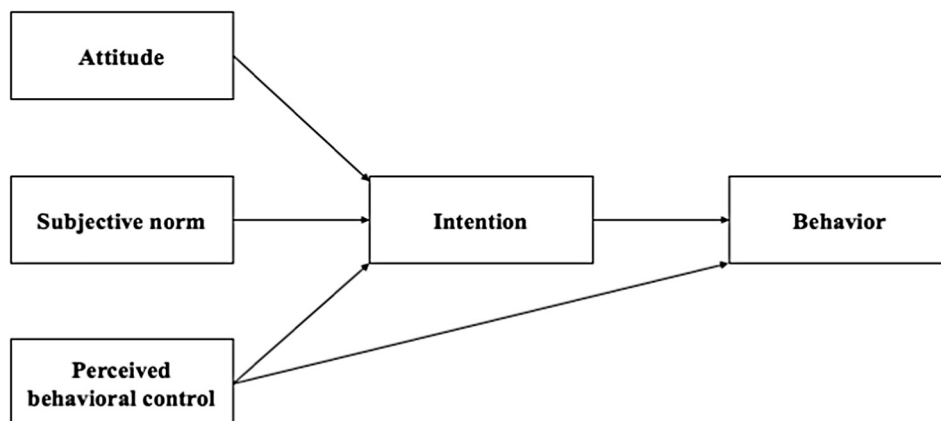

Fig. 1. The theory of planned behavior. adapted from Ajzen, 1991

According to the model, favorable attitudes, higher social approval (subjective norm), and higher perceived control over behavior would result in stronger intentions and consequently higher likelihood of performing a given behavior.

The TPB has applied various driver behaviors such as speeding (e.g., Elliott, Armitage, & Baughan, 2003), texting or using mobile phones while driving (Nemme & White, 2010; Zhou, Wu, Rau, & Zhang, 2009), drinking and driving (Castanier, Deroche, & Woodman, 2013; Moan & Rise, 2011), dangerous overtaking and tailgating (Parker, Manstead, Stradling, Reason, & Baxter, 1992), aggressive driving behaviors (Parker, Lajunen, & Stradling, 1998), driving without a license (Tseng, Chang, & Woo, 2013), and wearing seat belt (Brijs, Daniels, Brijs & Wets, 2011) are some of them. Furthermore, the TPB was used in interventions to change some traffic behaviors, such as increasing the use of safety helmets and seat belts, and compliance with speed limits (Brijs et al., 2011, Elliott & Armigate, 2009).

In addition to the driver behaviors, the TPB was applied to various pedestrian behaviors, such as distracted walking (Barton et al., 2016), red light violations (Zhou et al., 2016), and walking while intoxicated (Gannon, Rosta, Reeve, Hyde, & Lewis, 2014). These studies yielded the utility of the TPB framework in pedestrian intentions and behaviors. One of the earliest studies on the application of the TPB on pedestrian context indicated that attitudes, subjective norms, and the PBC are important predictors of pedestrian road crossing intentions (Evans & Norman, 2003). More recently, the utility of the TPB constructs in red light violations was also demonstrated (Zhou et al., 2016).

All this literature recommends theory-based socio-cognitive analysis of pedestrian behaviors. However, the literature is not unanimous regarding the significance of the TPB predictors and the strength of the relationships. For instance, Evans and Norman (1998) confirmed the TPB's efficacy in predicting pedestrian violations and found the PBC as the most reliable predictor. However, later, in Moyano-Diaz's (2002) study the attitudes were found to be the strongest predictor of the violation intentions, and the PBC was the third significant predictor following the subjective norm. Similarly, in another study instrumental attitudes and subjective norms were found as the significant predictors of violation intentions, but not the PBC (Zhou et al., 2016). They, also, have shown that the significance of the subjective norm vanishes when the descriptive norm is present.

Although the TPB is supported as a framework for pedestrian behaviors, whether our behaviors are entirely volitional is a pending question. The theory is criticized for its assumption that behaviors are logical, rational, and planned, and for disregarding the unconscious or heuristic processes (Sheeran, Gollwitzer, & Bargh, 2013). Some researchers point that in spontaneous risk-taking behaviors the TPB's predictive validity is reduced (Gibbons et al., 1998; Gibbons, Houlihan, & Gerrard, 2009; Conner & Sparks, 2005). For instance, an unfavorable view about pedestrian violations (i.e., negative attitudes) may not be able to withhold the pedestrian if they are willing to perform it when there is a gap in the traffic. Consequently, the prototype willingness model was developed by Gibbons, Gerrard, Blanton & Russell (1998) to explain risky behaviors of adolescents (e.g., smoking, binge drinking, reckless driving).

1.3. The prototype willingness model

The PWM suggests two pathways for behavioral performance: the *reasoned path* and the *social reactive path* (Fig. 2). In the reasoned path attitudes and subjective norms predict intention, and intention predicts the actual behavior as in the TPB, except for the PBC. The social reactive pathway is composed of *prototypes* and *willingness* in addition to the TPB components. The prototypes are images of a typical person engaging in the target behavior, composed of the *similarity* and *favorability* of
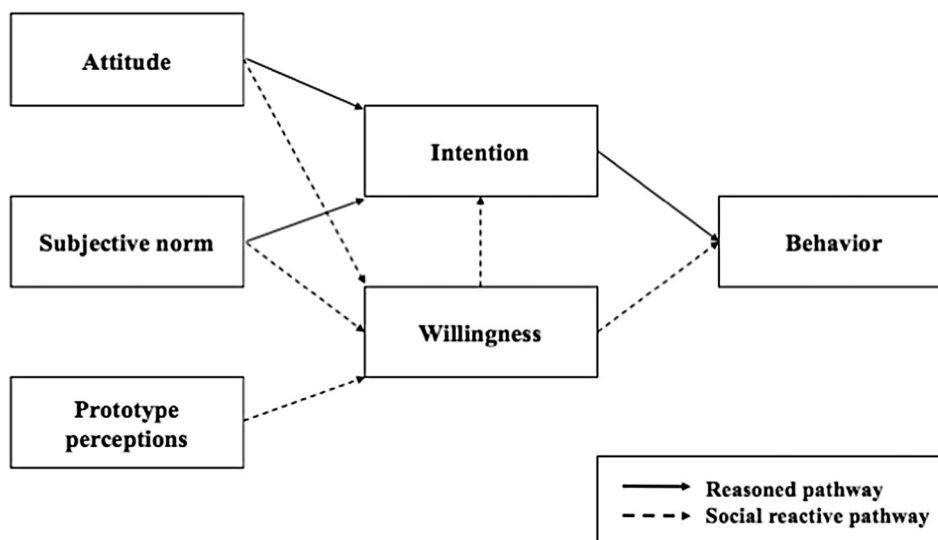

Fig. 2. The prototype willingness model. adapted from Gibbons et al., 1998

the prototypes to the individual. The prototypes affect the willingness, which is the tendency to perform a behavior when they have an opportunity. For example, when no car is coming by, individuals might cross the street while it is red for pedestrians, even though they do not have a prior intention. Thus, the PWM recognizes the possibility of behavioral performance even if intentions are not favorable toward performance (Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008). In sum, from the social reactive path, similarity and favorability of the prototype would result in higher willingness toward the behavior. Moreover, from the reasoned path, favorable attitudes and strong social approval would lead to higher intentions toward the behavior. Both the intentions and the willingness would predict the behavioral performance.

The PWM's utility has been demonstrated in road user behaviors such as speeding (Elliott et al., 2017), driving while intoxicated (Rivis, Abraham, & Snook, 2011), and cycling to school (Frater, Kuijer, & Kingham, 2017). Elliott and his colleagues compared TPB with the PWM in speeding behavior and found that willingness is stronger predictor of driver behavior than intention (Elliott et al., 2017). Still, pedestrian behaviors await to be investigated with the PWM framework. Since pedestrian behaviors may not be exclusively planned in nature, but usually be reactive to the external factors, the PWM might have a higher predictive value than the TPB.

1.4. Integrating the TPB and the PWM

Some researchers tested integrative models which blended the elements of the TPB and the PWM such as including willingness in a TPB model or adding paths from prototype perceptions to intentions. An early study that integrated the TPB with the PWM was conducted on health-protective and health-risk behaviors. The researchers investigated whether or not the PWM constructs (e.g. prototype similarity) predict intentions after controlling for the standard TPB variables (Rivis, Sheeran & Armitgae, 2006). The findings revealed that the PWM variables explain an additional percentage of variance after controlling for the TPB variables. The integrative model also provides a good fit to the data in organ donation registration and discussion intentions (Hyde & White, 2010). In addition to the standard paths suggested by the PWM model, organ donor prototypes were significantly associated with registration intentions. On the other hand, in a more recent study, where the adolescents' cycling to school was investigated with the TPB and the PWM, the results could not confirm the incremental value of prototypes over the TPB constructs (Frater et al., 2017). Therefore, authors concluded that cycling to school could be considered as primarily an intentional behavior rather than an opportunistic.

Overall, the efficacy of the models mostly depends on the target behavior. In the case of the pedestrian violations, an integrative model might provide a higher predictive power than the standard TPB and the PWM. In an integrative model, the PBC might predict individual's willingness, along with their intentions toward a pedestrian behavior as well. Moreover, the decision-making process of pedestrian violations might happen not only through the reasoned path as suggested by the TPB but also through a social-reactive path. For instance, people who perceive themselves similar to a typical violator would be more willing to involve in violation behaviors. Integrative model in the current study refers to an extended PWM that includes perceived behavioral control as predictors of intentions and behavior (Fig. 3).
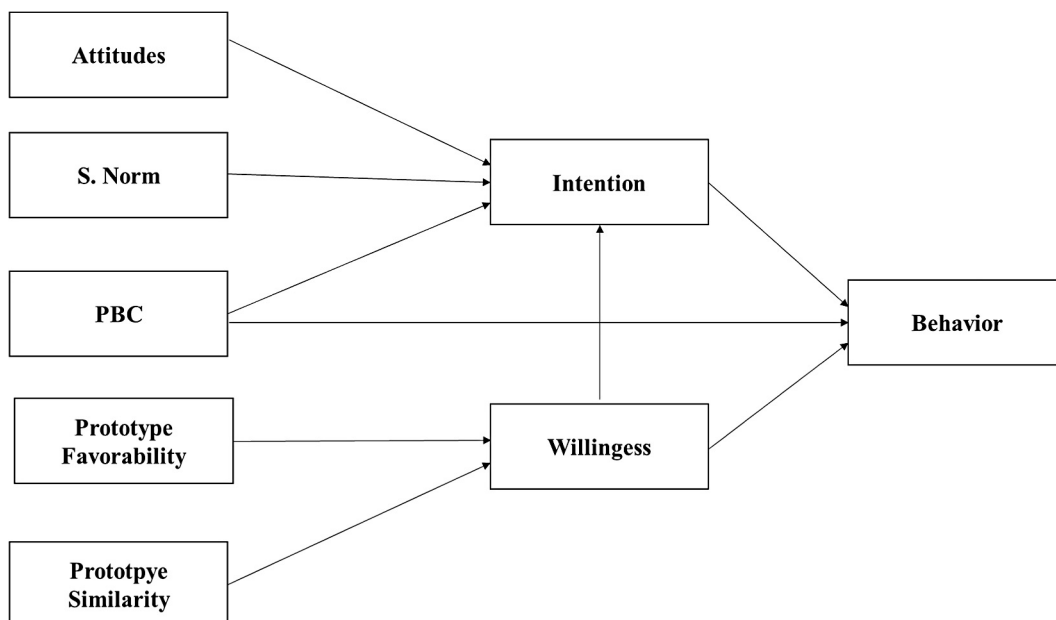

Fig. 3. Integrative model.

1.5. The present study

Based on the literature, we expect that the pedestrian behaviors might develop as reaction to situations rather than being pre-planned. Consequently, in the present study, we aimed to test our prediction of pedestrian behaviors being more reactive (based on the PWM) rather than reasoned (based on the TPB). That is, we compared these models in predicting pedestrian violations. Since the TPB is a well-established framework than the PWM, we took it as the reference model in our analyses, and compared the PWM and integrative models against it.

2. Method

2.1. Participants

We obtained the approval of the University Ethical Board and recruited the participants via in-class announcements. Five-hundred-nineteen participants took the survey in return for extra course credit. After dropping age outliers and participants with a prior accident experience, the statistical analyses were conducted with the remaining 486 participants. The mean age was 20.77 (SD = 1.68), and 70.4% were women (N = 342), but six participants did not indicate their gender (1.2%).

2.2. Procedure

After giving their consent, the participants provided their basic demographics. Then, the following definition of violation was given to participants to create a common understanding: *"Pedestrian violation occurs when a pedestrian crosses a roadway where regulations do not permit doing so. Exemplary behaviors include pedestrian's crossing between intersections without yielding to drivers and starting to cross a crosswalk at a signalized intersection without waiting for a permissive indication to be displayed."*

Following the definition, the participants filled out the TPB (attitudes, subjective norm, PBC, and intention) and the PWM scales (prototype similarity, prototype favorability, and willingness). Lastly, the participants filled out the transgression sub-scale of pedestrian behavior survey. At the end of the study, the participants were debriefed and thanked for their participation.

2.3. Measures

2.3.1. Attitudes
To measure attitudes toward violations, four semantic differential items were adapted from Rivis et al. (2006). The participants completed the sentence "For me, involving in a pedestrian violation would be…" with responses ranging from 1 to 7: *negative* to *positive, foolish* to *wise, bad* to *good, and unpleasant* to *pleasant.* The scale showed excellent reliability (α = 0.92).

2.3.2. Subjective norms
To measure subjective norms the participants were asked their perceived social approval about the violations from three referent groups: (a) close friends, (b) family, and (c) people who are important for them. The following items were used in a 5-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree): "My close friends do not bother with my pedestrian violation," "People who are important to me do not want me to involve in pedestrian violation" (reverse), "My family tolerates about my pedestrian violation," "People who are important to me agree that involving in a pedestrian violation is a bad thing" (reverse), and "People who are important to me do not approve pedestrian violation"(reverse). The reliability was satisfactory (α = 0.71).

2.3.3. Perceived behavioral control
Perceived behavioral control was assessed with a single item which reflects the self-efficacy: "It is easy for me to involve in pedestrian violation."

2.3.4. Intention
The participants' intention to involve in violation was measured with three items: "Probably I will involve in a pedestrian violation behavior," "It is likely that I will attempt to cross the street while the traffic light is red for pedestrians," and "I intend to engage in a pedestrian violation." The measure was reliable (α = 0.70).

2.3.5. Prototype perceptions
Firstly, a description of the violator prototype adapted from Gibbons, Gerrard, and McCoy (1995) was presented to participants. Then, their perception of similarity to the prototypes, and their rating of the favorability of the prototypes were asked.

Prototype similarity was measured using the following items: "Do the characteristics that describe the type of a pedestrian who violates the traffic rules also describe you?" and "Do the characteristics of a typical violator also describe you?" The answers ranged from 1 (*definitely no*) to 7 (*definitely yes*). The Cronbach's alpha indicated good reliability ($\alpha = 0.88$).

Prototype favorability was measured using two items. The participants indicated their level of favorability (1 *very unfavorable*, to 7 *very favorable*). The items were: "My view of pedestrians who cross the street while the traffic light is red for them is ..." and "My view of pedestrians who cross the street in places other than pedestrian crossing is ..." The reliability was satisfactory ($\alpha = 0.73$).

2.3.6. Willingness

The willingness to commit violations was measured with two scenarios based on previous research (Gibbons et al., 1995; Gibbons, Gerrard, & Lane, 2003; Zhou et al., 2016). At the end of each scenario, the participants responded to the willingness items by rating their likelihood of performing each item from 1 *(very unlikely)* to 7 *(very likely)*. The scenarios and the items were as follows:

Scenario 1. "Suppose you are walking to home, school, or work; or you are out for getting something done, and you need to cross the street. You are approaching the intersection, and the traffic light is red for pedestrians."
(a) wait for the green to cross the street, and (b) use a gap in traffic flow and attempt to cross the street.
Scenario 2. "Suppose you are walking to home, school, or work; or you are out for getting something done, and you need to cross the street. The crosswalk is 50 m away from you."
(a) cross street diagonally to save time, and (b) walk towards pedestrian crossing.

In sum, willingness was measured with four items in two scenarios with acceptable reliability ($\alpha = 0.68$).

2.3.7. Pedestrian violation

In order to get the participants' self-report violation behavior, the transgression subscale of pedestrian behavior scale was used (Granié et al., 2013). The participants answered the 8 items on a 7-point Likert scale. Scale included items such as "I cross the street even though the pedestrian light is red" and "I cross even though the light is still green for vehicles". The Cronbach's alpha indicated excellent reliability ($\alpha = 0.90$).

2.3.8. Demographics

The participants provided the following demographic information: age, gender, where they spent most of their lives (village, county, province, or metropolis), the frequency of their use of various transportation options (public transportation, driver in a personal vehicle, bicycle, motorcycle or other 2–3 wheeler, and pedestrian), duration they spend on each medium per day, and their involvement in active or near-miss accidents in the last 3 year.

3. Results

3.1. The data analytic plan

For the data analysis, first, the descriptive statistics and the correlations among the variables were analyzed (see Table 1 for the means, standard deviations, skewness, kurtosis, and the correlations among the variables). The correlation table suggests that there is a significant relationship among all study variables.

Secondly, the path models for pedestrian violations from the TPB, the PWM, and the integrative model were evaluated with path analyses using the SEM module of STATA 14. For these analyses, the maximum likelihood method was used, and the following indicators were used to evaluate the model fits: chi-square tests, root-mean-square error of approximation

Table 1
The means, standard deviations, skewness, and kurtosis values and bivariate correlations among study variables.

	1	2	3	4	5	6	7	8
1. Attitudes								
2. Sub. Norm	−0.35**							
3. PBC	0.35**	−0.32**						
4. Prototype Sim.	0.43**	−0.33**	0.51**					
5. Prototype Fav.	0.26**	−0.30**	0.33**	0.45**				
6. Intention	0.33**	−0.27**	0.61**	0.62**	0.48**			
7. Willingness	0.29**	−0.28**	0.47**	0.5**	0.51**	0.61**		
8. Violation Beh.	0.30**	−0.24**	0.52**	0.58**	0.59**	0.62**	0.74**	
Mean	2.35	3.79	2.83	3.09	2.77	3.03	3.43	3.44
Standard D.	1.39	0.65	1.13	1.42	1.09	0.89	1.16	1.19
Skewness	0.94	−0.20	0.19	0.36	0.11	0.00	0.04	0.34
Kurtosis	0.28	−0.20	−0.78	−0.50	−0.63	−0.23	−0.23	−0.24

(RMSEA), comparative fit index (CFI), and Tucker-Lewis Index (TLI). Further, the predictive power and the robustness of the given models were investigated with the standardized path coefficients and r^2 values. The standard TPB, the standard PWM, and the integrative model for pedestrian violations were compared. When testing each model, the modification indices were evaluated for being theoretically sensible. The suggested paths (e.g. a path from prototype similarity to intention) were included in the model only if they are theoretically justifiable.

3.2. Path analyses

Three path models for the standard TPB, the standard PWM, and the integrative model were compared using STATA (see Table 2 for a summary of the model fit indices; and see Table 3 for the direct and indirect effects for each model). The analyses for each model are provided below, firstly, for the TPB, followed by the PWM and the integrative model.

3.2.1. Model 1 – the theory of planned behavior

The standard model provided a good fit to the data (χ^2/df = 3.95/2, RMSEA = 0.045, CFI = 0.996, TLI = 0.986) with significant prediction of intentions by attitudes ($\beta = 0.12$) and PBC ($\beta = 0.56$). Moreover, behavior was also significantly predicted by intentions ($\beta = 0.46$) and PBC ($\beta = 0.25$). However, the subjective norm did not predict the intentions significantly. The model explained 39% and 42% variance in intentions and behaviors, respectively (see Fig. 4).

3.2.2. Model 2 – the prototype willingness model

The standard PWM did not provide a good fit to the data (χ^2/df = 152.40/6, RMSEA = 0.227, CFI = 0.863, TLI = 0.657). Thus, among the suggested modifications, the following theoretically reasonable paths were included to the standard model: omitting the paths from attitudes and subjective norms to the willingness, including paths from prototype favorability and similarity to violation intention, and from prototype favorability to behavior. After the modifications, the model provided a good fit to the data (χ^2/df = 19.54/5, RMSEA = 0.078, CFI = 0.986, TLI = 0.959), and explained a high percentage of variance in intentions (50%), willingness (39%), and violations (65%). The results indicated that willingness ($\beta = 0.53$) predicted violations better than intentions ($\beta = 0.18$). Moreover, prototype similarity was the most important predictor of intention ($\beta = 0.36$) and willingness ($\beta = 0.41$; see Fig. 5).

3.2.3. Model 3 – the integrative model

Since the initial model did not fit to the data well (χ^2/df = 240.61/10, RMSEA = 0.222, CFI = 0.802, TLI = 0.644), the modification indices were evaluated. In addition to the modifications suggested for the standard PWM in Model 2, another path from PBC to willingness was included. The modified integrative model provided a good fit to the data (χ^2/df = 12.49/5 RMSEA = 0.057 CFI = 0.994, TLI = 0.977), and the explained variance in intentions, willingness, and violations were 56%, 44%, and 66%, respectively. Overall, the explained variance in pedestrian violations in the integrative model was higher than the standard models of the TPB and the PWM (see Fig. 6).

4. Discussion

In the present study, we investigated the pedestrian violations' predictors with two prominent decision-making frameworks in social psychology: the theory of planned behavior and the prototype willingness model. These two theories and the integrative model were compared by treating the TPB as a reference model.

The literature on pedestrian behaviors indicates the TPB as efficacious in pedestrian behaviors. Nevertheless, since this literature is mainly interested in predicting intentions, but not behaviors (i.e., Evans & Norman, 2003; Zhou et al., 2016), the intention-behavior link was not confirmed for pedestrian behaviors. Therefore, in this study, we included the pedestrian violation behaviors, using the TPB as the baseline framework against which we tested the alternative models (that is, the PWM and the integrative model).

4.1. The comparison of the TPB, the PWM, and the integrative model

The predictive powers of the TPB, the PWM, and the integrative model were tested with three path analyses. The model fit indices indicated that the standard TPB fits the data well without any modifications. However, the modified PWM and the

Table 2
Goodness of fit test results and explained variance for each model.

	χ^2 (d.f.)	p	CFI	TLI	RMSEA	R^2 (Int.)	R^2 (Will.)	R^2 (Beh.)
Violation								
Standard TPB	3.949 (2)	0.139	0.996	0.986	0.045	0.39		0.42
Standard PWM	152.407 (6)	0.000	0.863	0.657	0.227	0.40	0.40	0.60
Modified PWM	19.54 (5)	0.002	0.986	0.959	0.078	0.50	0.39	0.65
Integrative Model	240.609 (10)	0.000	0.802	0.644	0.222	0.40	0.40	0.61
Modified Integrative Model	12.49 (5)	0.029	0.994	0.977	0.057	0.56	0.44	0.66

Table 3
Direct and indirect effects in path models of pedestrian violation behaviors.

	Intention			Willingness			Behavior		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
TPB									
Attitude	0.12**		0.12**					0.06**	0.05**
S. Norm	−0.04		−0.04					−0.02	−0.03
PBC	0.56**		0.56**				0.25**	0.26**	0.51**
Intention							0.46**		0.46**
PWM									
Attitude	0.04**		0.04**					0.01	0.01
S. Norm	−0.02		−0.02					0.00m	0.00
P. Similarity	0.36**	0.13m**	0.49**	0.41**		0.41**		0.30**	0.30**
P. Favorability	0.14**	0.10**	0.24**	0.33**		0.33**	0.24**	0.21**	0.45**
Willingness	0.32**		0.32**				0.53**	0.06**	0.59**
Intention							0.18**		0.18**
Integrative M.									
Attitude	0.01		0.01					0.00	0.00
S. Norm	0.02		0.02					0.00	0.00
PBC	0.31**	0.05**	0.37m**	0.22**		0.22**	0.14**	0.15**	0.29**
P. Similarity	0.26**	0.08**	0.33**	0.31**		0.31**		0.19**	0.19**
P. Favorability	0.14**	0.07**	0.21**	0.30**		0.30**	0.24**	0.17**	0.41**
Willingness	0.24**		0.24**				0.51**	0.02**	0.53**
Intention							0.10*		0.10*

N = 478, * $p < .05$, ** $p < .01$. The standardized effect sizes reported.
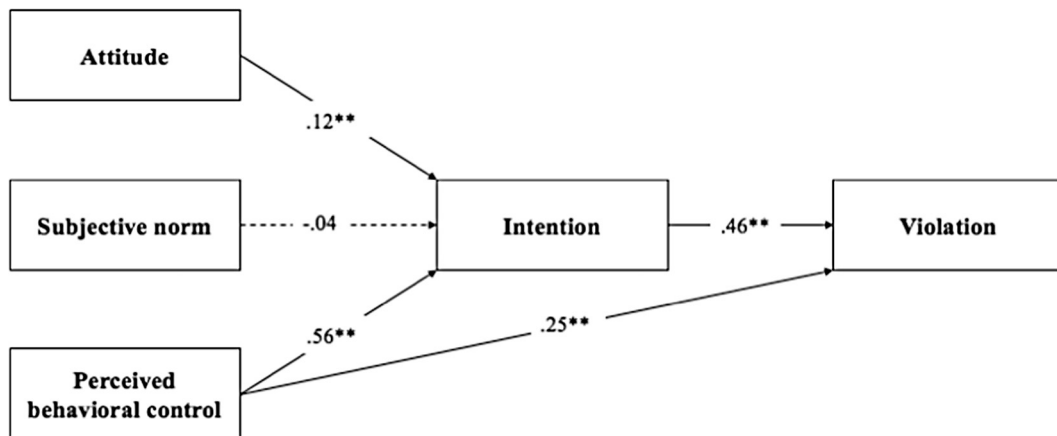

Fig. 4. The TPB model for violations. Dashed paths indicate non-significant associations.

modified integrative model were also provided good fit for the data, in addition to explaining more variance than the standard TPB.

4.1.1. The utility of the TPB

The TPB explained 39% of the variance in violation intentions, and 42% variance in violation behaviors in the path analysis, broadly in line with the previous research on the pedestrian behavior (Barton et al., 2016; Evans & Norman, 1998, 2003; Holland & Hill, 2007, Xu, Li, & Zhang, 2013, Zhou & Horrey, 2010).

Among the TPB constructs, the PBC emerged as the most important predictor of the intention. Moreover, the direct and indirect effect sizes of the PBC together revealed that it is the strongest predictor of the violations among the TPB variables. In addition to the sample's young age and high physical capabilities, the self-report data might have increased the effect sizes of the PBC. A meta-analysis reports that the PBC emerges as a better predictor of self-reported behavior than observed behavior (Armitgae & Conner, 2001). Furthermore, the same meta-analysis indicates that intentions are better explained by self-efficacy subcomponent of the PBC than the overall PBC, which includes both perceived control and self-efficacy. The authors of the meta-analysis advise researchers to use self-efficacy in the TPB studies to measure the PBC. Following this advice, in the current research, an indicator of self-efficacy, the perceived ease, was measured for the PBC. Overall, assessing self-
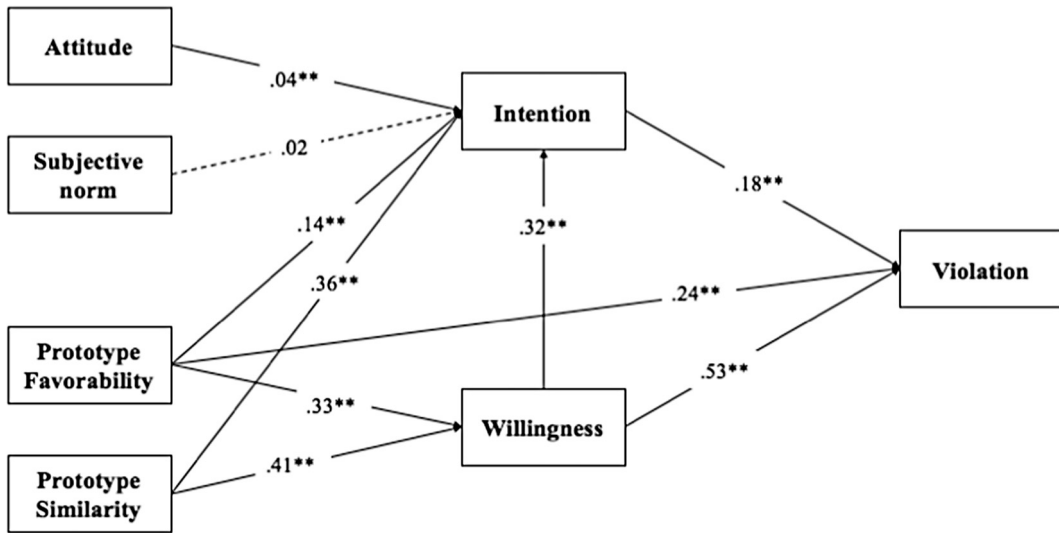
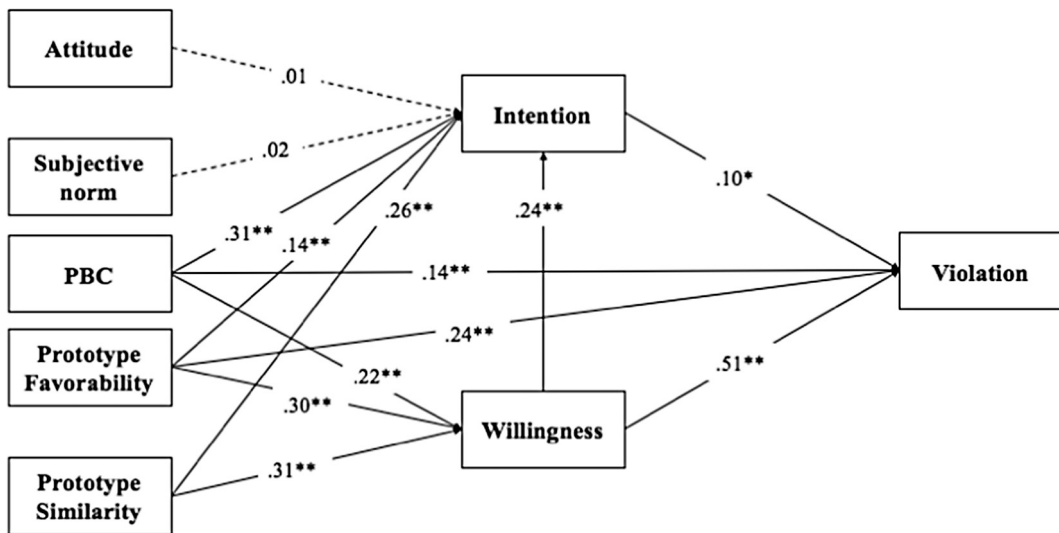**Fig. 5.** The PWM for violations. Dashed paths indicate non-significant associations.

Fig. 6. The integrative model for violations. Dashed paths indicate non-significant associations.

efficacy with a self-report measure might have contributed to the strong relationship among the PBC, intentions, and behavior in the present study.

While the PBC had such a strong association with violations, attitudes and subjective norms were not robust antecedents of violation intention and behavior. Attitudes had a significant but small association with violation intentions and behaviors, while the subjective norms had no association at all. Thus, the results were not consistent with the previous literature indicating that attitudes and subjective norms have robust and small to moderate effect sizes in predicting intentions (e.g., Evans & Norman, 1998, 2003; Zhou et al., 2009). The discrepancy between current findings and the previous literature might lie in the differences of measurement specificity. The previous studies measured specific behaviors; for instance, a violation in a busy road (Holland & Hill, 2007) or violation against signal alone (Evans & Norman, 1998; Zhou et al., 2009). In one study, researchers showed that the instrumental attitude, subjective norm, and the PBC are significantly associated with pedestrian red-light violations, and they are the strongest predictors of violation intentions (Zhou et al., 2016). However, we have defined the violation behaviors more broadly, and our measurement tools were designed to assess more general attitudes and subjective norms.

4.1.2. The PWM and the integrative model

The modified PWM and the modified integrative model fit the data well. Although both the intentions and willingness are found to be significant predictors of violations (parallel to the previous studies, e.g., Gibbons et al., 1998, 2004; Hyde & White, 2010), the results indicated that willingness was a better predictor of behavior than intentions. Elliott and the colleagues had a similar conclusion for speeding behavior, where they suggested the better utility of willingness over intention although both are significant predictors (Elliott et al., 2017). These modified models explained more variance than the TPB. These revised models explained an additional 11% to 17% variance in violation intentions and an additional 23% of the variance in violation behavior compared to the standard TPB.

The variance explained by the integrative model did not exceed the variance explained by the modified PWM. Furthermore, the beta weight of willingness in predicting behaviors is bigger than that of intentions. Therefore, the pedestrian violations seem to be performed through the social-reactive path to deal with the changing environmental demands, rather than the reasoned path. The finding that the integrated model does not have a predictive power beyond the PWM is the most crucial finding of this study. These results in violation are in line with Gibbons et al. (1998) argument that the social-reactive pathway is more appropriate in risk-taking behaviors. Overall, the current results point out that the pedestrian violations might be more reactive and performed through heuristic processes rather than being intentional and performed through systematic processes.

Besides willingness, prototype perceptions (similarity and favorability) were also stronger predictors of behavior than the TPB components except for the PBC. That is, perceiving a violator as similar and likeable may be associated with a tendency to commit a violation, parallel to Gerrard et al. (2008) suggestion of prototype perceptions influencing the behavior through the reactive path. However, in the current study, the prototype perceptions were significant predictors of intentions, as well. Thus, the reactive path interferes with the planned path in the PWM. This kind of interference between prototypes and intentions was demonstrated in a previous study on organ donation registration intentions and willingness (Hyde & White, 2010). Although the PWM does not suggest any association between prototype perceptions and intentions, the empirical findings point to the existence of an association.

4.2. Theoretical contributions

The present study contributes to our understanding of pedestrian violations by comparing the reactive and reasoned paths of decision-making. Overall, the current study demonstrates that both the TPB and the PWM are relevant theoretical approaches for understanding pedestrian violation.

The second contribution of this study is its identification of willingness as a more important predictor of behavior than intentions. Although as Ajzen (2011) pointed out both intention and willingness share the same underlying construct, willingness improves the predictive power in predicting behavior significantly. This outcome might be either due to a better measurement of the underlying readiness for behavior by willingness than intention, or willingness is not a complementary construct to increase TPB's predictive power but itself a primary predictor for reactive behaviors.

Thirdly, the current findings support the previous researchers' conclusion that subjective norm has a weaker association with intentions than attitudes and the PBC (see the meta-analysis, Armitage & Conner, 2001). Previously, the normative component was included in alternative ways, such as the moral norm (e.g., Hyde & White, 2010) and descriptive norm (e.g., Qu et al., 2016). Specifically, in pedestrian violation research, the utility of descriptive norms was demonstrated (Zhou, Romero & Qin, 2016). Along with this literature, the present findings point to descriptive norms as an important predictor of violations. The descriptive norms might set the baseline for social comparison, and influence the behavior directly.

Also, in contrast to the original PWM, prototype perceptions (similarity and favorability) were found associated with intentions and behaviors besides being associated with willingness. This unexpected finding was also evident in the literature as indicated in a recent meta-analysis of 80 different samples on the PWM (van Lettow, de Vries, Burdorf, & van Empelen, 2016). The authors of the meta-analysis indicated prototype perceptions as associated with intentions and behaviors along with willingness, and recommended adding these pathways to the PWM. Based on these empirical findings, including the suggested paths would improve the PWM.

In addition, to the best of our knowledge, the present study was the first attempt to investigate a pedestrian behavior using a behavioral measure in the investigated model with the TPB and the PWM. The present study has provided the data to support the intention-behavior and willingness-behavior links parallel to the theoretical suggestions. In sum, having the PBC, willingness, and prototype perceptions as the important predictors of pedestrian violations indicates that these are habituated and routine. Then, it can be assumed that performing the pedestrian violations follows a heuristic route, and systematic thinking is mostly not involved.

4.3. Applied implications

The findings of the present study have implications for behavior change towards a safer traffic environment and urban design. Firstly, the present findings point that willingness, prototype perceptions, and perceived behavioral control are the most important predictors of intention and behavior. Moreover, prototype perceptions and the PBC are important predictors of willingness. Therefore, the interventions would benefit from focusing on these constructs instead of the classical attitude and subjective norm components for behavior change in pedestrians.

Among these factors, the PBC and willingness are especially important for aberrant behaviors. The findings indicate that if the individual does not perceive an opportunity for unsafe behaviors, the likelihood of performing that behavior would be reduced. Therefore, the practitioners might consider reducing pedestrians' perceived control to reduce the violations in designing interventions. For instance, placing physical barriers would take away the control beliefs from the pedestrians right away. Furthermore, the barriers also inhibit the willingness by removing the opportunity for behavior.

In addition to the perceived behavioral control, prototype perceptions were important predictors of willingness, intentions, and behaviors. Therefore, prototype perceptions should be considered in implementation of behavior change interventions. The present findings indicate the importance of the negative portrayal of the violating pedestrian in the public service announcements. It is expected that identifying a typical violator with negative attributes will reduce the pedestrians' violation behavior. In line with this claim, in their deviance regulation theory (DRT; Blanton & Christie, 2003; Blanton, Stuart, & Van den Eijnden, 2001), Blanton and his colleagues suggest that people tend to act in a deviant manner if these counter-normative behaviors are appraised by the group. A recent study based on this theory found that negative framing of speeders on campus increase intention to obey speed limits (Demir, Demir, & Özkan, 2018).

The current study has implications not only for researchers, but also for the municipality and government officials. According to the findings, the road infrastructure should be appropriate to the pedestrians' behavioral tendencies. For example, a long red light duration for pedestrians would increase the likelihood of an illegal crossing. Similarly, the pedestrian crossing or overpass should be compatible with the pedestrians' optimal walking route to avoid violations. Therefore, the pedestrians' point of view should also be taken while designing the traffic infrastructure concerning pedestrians.

Finally, the policymakers should ensure a convenient walking area for pedestrians in highly populated urban areas. Particularly, cars parking in pavements force pedestrians to commit a violation and dangerous walking behaviors by exposing themselves to the cars on the road. A strict policy against these violating drivers is required. Occupied pavements will both affect the pedestrians' behavioral performance and strengthen unsafe if-then statements, which could be generalized to other walking related violations.

4.4. Limitations

The present study has some limitations as any other study. Firstly, the sample mostly consists of young women. Regarding gender, women are less aberrant than men in traffic in general. Therefore, the low effects of the models might have been affected by the gender composition of the sample. In terms of age, the previous literature suggests that by age the importance of intentions increase relative to willingness in predicting behavior (Pomery, Gibbons, Reis-Bergan, & Gerrard, 2009). Therefore, the present findings should be interpreted carefully by future researchers by keeping the gender and young age of the participants in mind.

Besides, in the original PWM, the past behavior is the antecedent of attitudes, subjective norms, and prototype perceptions. However, since the TPB was the baseline model for comparison, the past behavior was not included in the study. Incorporating it would have improved the PWM's performance.

Finally, Ajzen and Fishbein (1980) suggested that specific definitions of the target behavior, action, context, and time of the behavior should be provided in the TPB studies. However, his suggestion was not completely applied in the current study due to the nature of the target behavior. Since pedestrian violation is a daily activity requiring no extra effort, it is hard to specify them parallel to Ajzen's suggestion. Therefore, a general measurement was considered to be more appropriate for this context with only a definition of violation behavior to create a common understanding among participants. Still, a confirmation of the current findings with more specific measurements would be a good contribution to our understanding of pedestrian violations.

4.5. Conclusion

To sum up, the current study suggests that the PWM emerges as a robust theoretical framework that might enhance our current understanding of pedestrian violations and other traffic behaviors. More importantly, it has higher predictive power than the TPB. The importance of behavioral control in the integrative model suggests that these theoretical frameworks are complementary rather than rivalry. We hope that further empirical research will clarify this issue.

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