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Why drivers refuse to yield: power of neutralization over deterrence in Chinese urban cross-walks

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Drivers' yielding behavior toward pedestrians is a key determinant of urban road safety. Although deterrence-based interventions such as fines and penalties are widely employed, little is known about the psychological rationalizations drivers use to justify non-compliance. To address this gap, this study integrates neutralization theory and deterrence theory to examine the determinants of yielding intentions. A structural equation model (SEM) was constructed using survey data from 400 licensed drivers in Wuhan, China, to evaluate the dual effects of neutralization techniques and deterrence mechanisms. The results show that three neutralization strategies—denial of injury, denial of victim, and defense of necessity—significantly undermine yielding intentions, while deterrence mechanisms such as formal sanctions and shame exert positive but comparatively weaker influences. Among these factors, denial of victim emerges as the strongest deterrent to yielding, and license-related penalties are perceived as more severe than monetary fines. Overall, the findings demonstrate that the negative impact of neutralization substantially outweighs the positive effect of deterrence, highlighting the limitations of overreliance on punitive measures and underscoring the importance of addressing drivers' moral disengagement to enhance pedestrian safety.

KEYWORDS

traffic safety, yield to pedestrians, structural equation model (SEM), neutralization theory, deterrence theory

1 Introduction

In recent years, pedestrian crossing safety has been a serious issue. According to the World Health Organization, over 1.19 million people died on roads in 2021, with pedestrians accounting for 23% of these fatalities. (World Health Organization, 2023). Pedestrians face heightened injury risks when crossing streets, particularly at unsignalized crossings (Li C. et al., 2021; Zafri et al., 2022). Therefore, regulating motor vehicle behavior and increasing driver yielding rates at unsignalized crosswalks is critical. To address this issue, China's public security traffic management departments launched a nationwide campaign in 2017 specifically targeting motorists' failure to yield to pedestrians. This initiative combined policy enforcement, public education campaigns, infrastructure improvements (e.g., enhanced crosswalk designs), and the installation of monitoring equipment to mitigate vehicle-pedestrian conflicts. The campaign proved highly effective: for instance, driver yielding rates at zebra crossings in Xi'an surged from 3.6% to 68.6% within the same year (Wang et al., 2021).

However, the policy's effect proved unsustainable. After the 2017 enforcement campaign ended, the yielding rate in Xi'an fell sharply—from 68.6% to 34.1% in just 1 year (Wang et al., 2021). Drivers are highly sensitive to the presence of electronic police (e-Police) and yield far more often when cameras are visible than when they are not. At locations without camera surveillance, the compliance rate remains only slightly above 30% (Li H. et al., 2021; Malenje et al., 2019). These findings indicate that most drivers have yet to internalize yielding as a habitual, civilized behavior, so pedestrians continue to face substantial risk when crossing the road. It is therefore imperative to investigate the underlying factors and mechanisms that lead drivers to refuse or fail to yield from a psychological perspective. This study examines the decision-making mechanisms behind drivers' refusal to yield to pedestrians. Which is essential for designing sustainable countermeasures and improving long-term pedestrian safety.

This study aims to assess how drivers' yielding intentions are influenced by their psychological functioning and perceptions, drawing on neutralization theory and deterrence theory from criminal psychology. Specifically, the objectives are to (1) identify the neutralization techniques and deterrence methods that affect drivers' yielding intentions, (2) determine the relationships between these techniques/methods and yielding intentions, and (3) compare the relative impacts of neutralization techniques *versus* deterrence methods on drivers' yielding intentions.

The subsequent sections of this manuscript are structured as follows: Section 2 reviews the relevant literature. Section 3 presents the theoretical framework and yielding-behavior model.

Section 4 details the methodology, including data collection and analysis. Section 5 reports the results. Section 6 discusses the findings. Section 7 concludes and outlines policy implications.

2 Literature review

2.1 Objective factors affecting drivers' yielding behavior

Survey studies consistently show that drivers' yielding behavior is significantly associated with individual characteristics such as age, gender, education level, and altruistic attitudes. Specifically, older drivers, female drivers, and those with lower educational attainment are more likely to yield (Hirun, 2016; Yang et al., 2020; Yu et al., 2023). Yielding is also shaped by the dynamic interaction between drivers and pedestrians. When pedestrians establish eye contact or use explicit hand gestures at the crossing, the probability that drivers will yield increases markedly (Ren et al., 2016). In addition, the speed and size of the pedestrian group influence yielding rates: drivers are more inclined to yield when pedestrians cross quickly and when the group is large (Schneider et al., 2018; Sogbe, 2024; Zhao et al., 2020). From a management perspective, installing yield-to-pedestrian signs, removing parked vehicles near crossings, and deploying advance-warning devices or automated enforcement (e-Police) have all been shown to increase yielding rates (Høye and Laureshyn, 2019). Collectively, these studies have focused primarily on observable, objective factors. They have not examined how drivers' subjective psychological states—such as

psychological rationalization, deterrence perception—may influence the decision to yield.

2.2 Psychological factors affecting drivers' yielding behavior

Only a handful of studies have explicitly examined the psychological determinants of drivers' yielding to pedestrians. Using an extended Theory of Planned Behavior (TPB) questionnaire and structural equation modeling, Yang et al. (2020) demonstrated that attitude, subjective norms, perceived behavioral control, and risk perception all exert significant, direct effects on drivers' yielding intention. More recently, Yu et al. (2023) employed a relational matrix combined with stratified multivariate non-parametric regression to show how altruism and drivers' perceived stress influence prosocial driving behavior, actual yielding, and yielding attitudes. Sarker et al. (2024) used behavior change theories and designed a questionnaire based on the capability, opportunity, motivation and behavior (COM-B) model to survey 202 drivers on two highways in Bangladesh, aiming to identify the key factors influencing drivers' yielding behavior. Based on the extended theory of planned behavior (TPB) model, Xin et al. (2023) added two policy-related variables, namely, knowledge about the policy (KN) and perceived effectiveness (PE), to explore the potential positive and negative effects of the “yield to pedestrians” (YTP) policy on pedestrians' risky behaviors.

2.3 Application of deterrence theory in traffic behavior

In traffic-behavior regulation, deterrence theory remains the dominant framework underpinning road-policing strategies (Hassan et al., 2024). The theory has been widely employed to improve compliance with traffic rules. Numerous studies have applied it to traffic behaviors such as drunk driving (Freeman and Watson, 2006), drug driving (Armstrong et al., 2018), speeding (Truelove et al., 2017), and mobile-phone use while driving (Truelove et al., 2019). Typical deterrence-based policing measures include random breath testing (RBT) and automated enforcement (e-police) targeting offences such as speeding and failure to yield (Li H. et al., 2021). The certainty of sanction is regarded as the most effective factor in generating the deterrent effect of speed cameras (Freeman et al., 2017) and in curbing speeding behavior (Truelove et al., 2017).

2.4 Application of neutralization theory and deterrence theory in other fields

Drivers' failure to yield to pedestrians when required by law constitutes a traffic offence. The decision to commit such an offence is shaped by drivers' psychological conditioning and their subjective assessment of the likelihood and severity of sanctions (Chen et al., 2022). Two complementary criminological frameworks—neutralization theory and deterrence theory—offer insight into this process. Neutralization theory posits that

individuals often rationalize illegal or deviant behavior with justifications they regard as legitimate (Sykes and Matza, 1957). Deterrence theory adds that offenders psychologically weigh the anticipated benefits against the expected costs before deciding to violate the law (Ugrin and Michael Pearson, 2013). Taken together, these perspectives have been successfully applied to behaviors such as personal Internet use at work (Cheng et al., 2014), employee violations of information-system security policies (Siponen and Vance, 2010), cyberbullying (Zhang et al., 2016), and persistent car use despite environmental concerns (Uba and Chatzidakis, 2016).

A review of the existing literature indicates that studies on yielding to pedestrians and improvement measures have largely overlooked the psychological decision-making mechanisms underlying the intention to yield, particularly from the perspectives of psychological rationalization and perceived deterrence. Although deterrence theory has been widely applied in traffic behavior research, no studies have explored how neutralization techniques and deterrence mechanisms jointly influence drivers' decisions to yield (or not yield) to pedestrians. However, research in other domains provides a basis for such an investigation and can be drawn upon for insights.

3 Research framework

Neutralization theory and deterrence theory, both rooted in criminological psychology, provide robust accounts of the cognitive processes that precede rule-breaking behavior. Although drivers' failure to yield to pedestrians is classified as a traffic offence rather than a criminal act, the psychological mechanisms underlying the decision to offend remain comparable. Consequently, these two theories are adopted as the conceptual foundation for modelling drivers' intention to yield to pedestrians.

3.1 Related theories

3.1.1 Neutralization technology theory

Neutralization theory posits that individuals use a repertoire of cognitive strategies to rationalize deviant behavior (Siponen and Vance, 2010; Topalli et al., 2014). The techniques include denial of responsibility, denial of injury, denial of the victim, condemnation of the condemners, appeal to higher loyalties, defense of necessity, and metaphor of the ledger. In the context of drivers' yielding (or non-yielding) to pedestrians, we exclude condemnation of the condemners and appeal to higher loyalties. Chinese drivers seldom question the legitimacy of the Road Traffic Safety Law's yielding requirement, and this regulation does not conflict with any higher-order legal principles. Accordingly, we focus on the remaining five neutralization techniques as potential justifications for non-yielding behavior.

3.1.1.1 Denial of responsibility

Individuals frequently attribute their deviant behavior to environmental or situational factors. For example, a driver who fails to yield may deny personal responsibility by citing ambiguous traffic regulations, inadequate driver training, or limited sight

distance at the crossing. Empirical studies show that both the clarity of legal requirements and perceived road conditions influence drivers' yielding behavior (Hirun, 2016; Schneider et al., 2018). Therefore, we hypothesize that non-yielding drivers employ the 'denial of responsibility' technique, shifting blame to external circumstances to rationalize their offence.

3.1.1.2 Denial of injury

Some drivers deny any injurious consequences of their behavior. They argue that, as long as they remain attentive, their failure to yield will not endanger pedestrians, who—according to these drivers—will simply select a sufficiently large gap to cross safely, especially when they actively keep a distance from vehicles (Zafri et al., 2022). By invoking this 'denial of injury' technique, drivers rationalize their non-yielding as harmless and thus acceptable.

3.1.1.3 Denial of the victim

With neutralization theory, 'denial of the victim' implies that offenders reassign blame by portraying the victim as culpable. The offender recasts himself as the aggrieved party, while the actual victim is framed as the rule-breaker (Sykes and Matza, 1957). In the yielding context, drivers may claim they are "in the right" because pedestrians' crossing behavior is perceived as discourteous or illegal. Pedestrians' assertiveness, especially walking briskly to the crosswalk, resulted in higher yielding. On the contrary, hesitation, dispersion, and non-compliance when crossing the street can lead to a low yielding rate by drivers (Zafri et al., 2022). Consequently, we posit that drivers invoke 'denial of the victim' to justify non-yielding by attributing blame to pedestrians' street-crossing behavior.

3.1.1.4 Defense of necessity

The 'defense of necessity' is based on the justification that if rule-breaking is viewed as necessary, one should not feel guilty when committing the action (Minor, 1981). Drivers may invoke this technique to rationalize non-yielding as a response to situational pressures: they argue that failing to yield is necessary to prevent traffic congestion, avoid rear-end collisions, or maintain the prevailing traffic flow (Nordfjærn and Şimşekoğlu, 2014).

3.1.1.5 Metaphor of the ledger

The "metaphor of the ledger" holds that individuals view their prior good deeds as credits that can offset subsequent misconduct (Klockars, 1974). Previous research shows that employees in corporate environments occasionally invoke this technique, arguing that an otherwise exemplary record justifies isolated rule violations (Siponen and Vance, 2010). Similarly, drivers could argue that their excellent performance in other aspects compensates for their occasional failure to yield to pedestrians.

Based on the preceding discussion, we propose the following hypotheses:

Hypothesis 1: Denial of Responsibility (DR) is negatively associated with the drivers' yielding intention to pedestrians.

Hypothesis 2: Denial of Injury (DI) is negatively associated with the drivers' yielding intention to pedestrians.

Hypothesis 3: Denial of the Victim (DV) is negatively associated with the drivers' yielding intention to pedestrians.

Hypothesis 4: Defense of Necessity (DN) is negatively associated with the drivers' yielding intention to pedestrians.

Hypothesis 5: Metaphor of the Ledger (ML) is negatively associated with the drivers' yielding intention to pedestrians.

3.1.2 Deterrence theory

Deterrence theory suggests that punishment deterrence improves the unregulated behavior of perpetrators (Ugrin and Michael Pearson, 2013). In the traffic context, official formal punishment operates as a negative incentive: drivers weigh the expected costs of sanction against the immediate benefits of non-yielding (Tavares et al., 2008; Wenzel, 2004; Pratt and Cullen, 2000) extend deterrence theory to include informal sanctions and shame, both of which can amplify deterrence by adding social and reputational costs. Chinese regulations require motorists to slow and stop for pedestrians at zebra crossings. Violators face a ¥100 fine and a three-point deduction; accumulation of 12 points within a year results in licence revocation (People's Republic of China, 2021). Empirical evidence indicates that such formal penalties reduce violations (Lee et al., 2018), and help establish a dynamic equilibrium in which yielding behavior is sustained by the threat of sanction (Chen et al., 2022). However, traffic offences are not yet integrated into China's social-credit system at present in China, informal sanctions are not emerging yet. However, methods such as exposure and announcements have been adopted to implement shaming punishments. Because Chinese people's judgment or choice toward something may be affected by their family members, friends, colleagues, or classmates (Yang et al., 2020).

Therefore, two deterrent methods of formal sanction and shame of deterrence theory are selected to use in motor vehicle yielding to pedestrians, and following hypotheses are proposed.

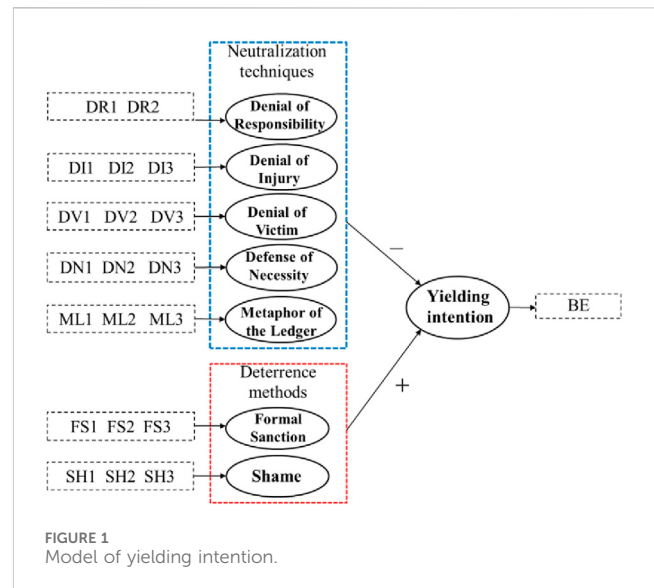
Hypothesis 6: Formal Sanction (FS) is positively associated with drivers' yielding intention to pedestrians.

Hypothesis 7: Shame (SH) is positively associated with the drivers' yielding intention to pedestrians.

3.2 SEM model of yielding intention

This study employs seven constructs to explain drivers' intention to yield to pedestrians: five neutralization techniques (denial of responsibility, denial of injury, denial of victim, defense of necessity and metaphor of the ledger) and two deterrence methods (formal sanctions and shame). All constructs are grounded in neutralization theory, deterrence theory and relevant literature reviews. The complete research model is presented in Figure 1.

The five neutralization techniques are measured by two, three, three, three, three items respectively; the two deterrence methods constructs are measured by three items each. The drivers' yielding intention is measured by one items (see Table 1). Most of the construct items were adopted from previously validated



instruments. Specifically: Items for 'denial of responsibility' and 'denial of injury' were adapted from (Siponen and Vance, 2010) to fit the context of yielding intentions to pedestrians. Items for "denial of victim" originated from (Sykes and Matza, 1957) and were adapted from Cheng et al. (2014). Items for "defense of necessity" and "metaphor of the ledger" were used by Zhang et al. (2016) and adapted to the context of yielding intentions to pedestrians. Items for "formal sanctions" and "shame" were modified from Zhang et al. (2016) by omitting irrelevant content to ensure contextual fit. The dependent variable—the yielding intention—was measured using two items. One item was adapted from (Siponen and Vance, 2010) and states "what is the chance that you would yield to pedestrians". All measurement items and their descriptive statistics are presented in Table 1.

4 Methodology

4.1 Data collected

A structured questionnaire was developed to collect data in Wuhan, China, during 2023. The instrument captures drivers' psychological rationalizations, deterrence perceptions, and yielding intentions using 5-point Likert-scale items. A pilot survey was conducted before the main data collection to refine wording and ensure reliability.

Data were collected through both online and offline channels. Electronic questionnaires were distributed via Wenjuanxing, yielding 400 usable responses. Additionally, 300 paper questionnaires were handed out to drivers in Wuhan's public parking lots, of which 216 were returned complete. All responses were anonymous.

We excluded any questionnaire indicating an age below 18 years and any online response completed in less than 60 s or more than 180 s. These criteria yielded 400 valid responses. The demographic profile of the final sample is presented in Table 2. All items were measured on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree).

TABLE 1 Items for testing intentions of yielding to pedestrians.

Latent variables	Variables	Description of observed variables
Denial of Responsibility (DR)	DR1	Poor visibility on the road, so it is not easy to judge that pedestrians are passing
	DR2	Insufficient information on signs and markings to slow down or brake for pedestrians
Denial of Injury (DI)	DI1	I drive carefully at a low speed and it will not cause any danger or injury
	DI2	I avoid pedestrians and it will not cause danger or injury
	DI3	There is still enough distance away from pedestrians and it will not cause danger or injury
Denial of Victim (DV)	DV1	Pedestrians are jaywalking, so I think cannot give way to them
	DV2	Pedestrians crossing the street in Chinese style are too serious and unchecked, no need to yield
	DV3	Pedestrians are crossing the street slowly and one after another, once stop to yield, I have to wait for a long time
Defense of Necessity (DN)	DN1	I'm in a hurry, so I do not have the time to yield
	DN2	If the others do not yield to pedestrians, I can also not yield to them either
	DN3	Yielding to pedestrians will cause traffic congestion and may even lead to accidents
Metaphor of the Ledger (ML)	ML1	I always obey the traffic rules, so it's okay if I do not yield to pedestrians occasionally
	ML2	I am usually respected and recognized in other aspects, so I can be forgiven for not yielding to pedestrians occasionally
	ML3	I have a good education, it does not matter if I do not yield to pedestrians once in a while
Formal Sanction (FS)	FS1	I care much about if I was fined 100 RMB for failing to yield to pedestrians in front of a crosswalk
	FS2	I care much about if I get 3 demerit points for not yielding to pedestrians
	FS3	I care much about if I am penalized for not yielding to pedestrians, such as having to relearn traffic regulations or participate in maintaining traffic order
Shame (SH)	SH1	I will feel ashamed if I was exposed on the roadside display screen for not yielding to pedestrians
	SH2	I will feel ashamed if my leadership and colleagues knew about my behavior of not yielding to pedestrians
	SH3	I will feel ashamed if my friends and family were informed of my failure to yield to pedestrians
Yeilding intention	BE	What is the chance that you would yield to pedestrians?

4.2 Data analysis

Pearson's correlation coefficient measures the strength and direction of linear association between two continuous variables, ranging from -1 to $+1$, with the corresponding p -value indicating statistical significance. We used Pearson bivariate correlation analysis in R 3.6.3 to examine the inter-correlations among the observed variables.

Reliability refers to the extent to which a multi-item scale accurately reflects the underlying constructs, accounting for measurement errors. Cronbach's alpha and composite reliability (CR) are widely used to assess the internal consistency of variables representing each construct. It is generally recommended that both composite reliability and Cronbach's alpha exceed 0.7.

Factor loadings indicate the strength of the relationship between observable variables and their underlying constructs (F. Hair Jr et al., 2014). For satisfactory convergent validity, each observable variable should have a factor loading of at least 0.5 (Hulland, 1999). Convergent validity assesses how well a set of items measures a single construct. It is evaluated using the average variance extracted (AVE), with values of 0.5 or higher indicating that the construct explains at least half of the variance of its items.

Confirmatory factor analysis (CFA) was conducted to assess the reliability and validity of the measurement model. Structural equation modeling (SEM) was employed using AMOS 20.0 to build and test the hypothesized relationships. The maximum likelihood estimation (MLE) method was used to estimate the relationships between observed and unobserved variables. Eight commonly used goodness-of-fit indices were employed to evaluate the overall model fit. A good fit was indicated by the following criteria: the ratio of χ^2 to degrees of freedom ($\chi^2/df < 3$), the goodness-of-fit index (GFI > 0.90), the adjusted goodness-of-fit index (AGFI > 0.80), the comparative fit index (CFI > 0.90), the normed fit index (NFI > 0.90), the incremental fit index (IFI > 0.90), the Tucker–Lewis index (TLI > 0.90), and the root mean square error of approximation (RMSEA < 0.06).

Path coefficients represent the hypothesized relationships between constructs (F. Hair Jr et al., 2014). Once the reliability and validity of the measurement models are confirmed, it is critical to estimate the significance of the path coefficients to test the hypotheses within the structural model. The significance of path coefficients is assessed using p -values. A p -value below 0.05, 0.01, or 0.001 indicates that the significance level is 5%, 1%, or 0.1%, respectively, and the corresponding hypothesis is accepted.

TABLE 2 The composition of the effective samples (N = 400).

Category	Subcategory	Frequency	Percentage (%)
Gender	Male	217	54.25
	Female	183	45.75
Age	18–30 years old	172	43.00
	31–40 years old	131	32.75
	41–50 years old	85	21.25
	51 year old and above	12	3.00
Driving Age	<1 year	93	23.25
	1–3 years	127	31.75
	3–6 years	80	20.00
	6–10 years	66	16.50
	>10 years	34	8.50
Education	High school below	20	5.00
	High school	63	15.75
	College	239	59.75
	Postgraduate and above	78	19.50

4.3 Model analysis

In SEM, standardized path coefficients eliminate differences in measurement units, and their absolute values reflect the effect size (Hair et al., 2022). Typically, the standardized path coefficients of the direct and indirect paths of a specific latent variable are analyzed to compare the strength of their influences. For multiple paths sharing the same theoretical mechanism (e.g., “facilitators”), comparisons are made either between the path coefficients of second-order latent variables or between the relevant statistics of the standardized path coefficients of latent variables within the same category (Ding et al., 2021).

In the present study, “Intra-group Average Effect Sizes” (defined as the mean of standardized coefficients) was adopted as the comprehensive effect. This approach parallels practices in meta-analysis, where multiple effects (e.g., Cohen’s d , Hedges’ g) are averaged to estimate an overall effect (Borenstein et al., 2021). Similarly, in nonlinear models (e.g., Logit, Probit), scholars often compare average marginal effects (AMEs) across predictors (Mize et al., 2019). Thus, intra-group average effect sizes can be viewed as an extension of the AME concept into SEM.

To implement this analytical framework, the following steps were conducted: First, the mean of standardized coefficients for significant paths within each category of constructs was calculated. Second, the bootstrapping method was employed to test the significance of differences between the two group means. Specifically, non-overlapping confidence intervals were verified as the criterion for determining statistical significance. Through this approach, the relative “comprehensive effect” of the two theoretical dimensions was compared.

5 Results

5.1 Analysis of measurement model

The results related to the measurement model are presented in Tables 3–5. Table 3 shows that the majority of observed variables exhibited statistically significant correlations. However, DR1, DR2, DN2, ML2 and ML3 did not show significant correlations with BE (Behavioral intention).

As shown in Table 4, all measures exceeded the recommended threshold value of 0.7. Cronbach’s alpha values ranged from 0.750 to 0.905, and composite reliability (CR) values ranged from 0.710 to 0.906. These results indicate that the observable variables have an adequate degree of internal consistency and reliability.

This study exclusively involves reflective observable variables since the constructs determine the items; in other words, the arrows in Figure 2 point from the constructs to the observable variables. As shown in Table 4, all standardized loading factors are greater than 0.5. Additionally, AVE values range from 0.530 to 0.763, all exceeding the recommended threshold. These results indicate that the questionnaire data exhibit good reliability and validity, making it suitable for factor analysis.

Although the Chi-square statistic ($\chi^2 = 450.564$, d.f. = 173, $p < 0.001$) is significant, the measurement model provided a reasonable fit to the data according to the goodness-of-fit from CFA (Table 5). Additionally, all factor loadings are higher than the threshold value (0.5). Most of the observed variables load relatively highly on their respective latent variables (i.e., denial of responsibility, denial of injury, denial of victim, metaphor of the ledger, defense of necessity, formal sanction, shame), and there is

TABLE 3 Correlations among observed variables.

Variables	DR 3	DR 4	DI1	DI 2	DI3	DV1	DV2	DV3	DN1	DN2	DN3	ML1	ML2	ML3	FS1	FS2	FS3	SH1	SH2	SH3	BE
DR1	1.00																				
DR2	0.61**	1.00																			
DI1	−0.07	0.01	1.00																		
DI2	−0.04	0.02	0.75**	1.00																	
DI3	−0.05	−0.02	0.73**	0.80 **	1.00																
DV1	0.05	−0.04	−0.34**	−0.39**	−0.37**	1.00															
DV2	0.01	−0.02	−0.51**	−0.47**	−0.47**	0.59**	1.00														
DV3	0.05	0.01	−0.48**	−0.50**	−0.48**	0.56**	0.62**	1.00													
DN1	−0.02	−0.02	0.51**	0.50**	0.51**	−0.34*8	−0.53**	−0.63**	1.00												
DN2	−0.01	0.02	0.50**	0.53**	0.52**	−0.27**	−0.52**	−0.53**	0.63**	1.00											
DN3	−0.03	0.03	0.35**	0.34**	0.38**	−0.41**	−0.53**	−0.56**	0.53**	0.58 **	1.00										
ML1	0.02	−0.02	−0.51**	−0.50**	−0.54**	0.35**	0.49**	0.53**	−0.54**	−0.69**	−0.56**	1.00									
ML2	−0.02	−0.06	−0.52**	−0.49**	−0.47**	0.25**	0.46**	0.44**	−0.58**	−0.68**	−0.45**	0.71**	1.00								
ML4	0.03	0.00	−0.49**	−0.51**	−0.48**	0.23**	0.42**	0.43**	−0.51**	−0.67*8	−0.43**	0.72**	0.77**	1.00							
FS1	0.06	0.02	0.09*	0.12**	0.19**	−0.24**	−0.18**	−0.16**	0.14**	0.09**	0.23**	−0.06	−0.02	−0.03	1.00						
FS2	0.12**	0.09**	0.12**	0.10**	0.18**	−0.23**	−0.17**	−0.17**	0.10**	0.07	0.17**	−0.05	−0.04	−0.02	0.65**	1.00					
FS3	0.00	0.00	0.04	0.01	0.05	−0.11**	−0.10**	−0.10**	0.01	0.00	0.08*	0.03	0.04	0.04	0.37**	0.47**	1.00				
SH1	0.03	0.07	0.12**	0.09*	0.13**	−0.13**	−0.19**	−0.12**	0.05	0.12**	0.20**	−0.16**	−0.11**	−0.09*	0.07	0.08*	−0.09*	1.00			
SH2	0.07	0.08**	0.15**	0.11**	0.15**	−0.14**	−0.18**	−0.13**	0.09*	0.13**	0.20**	−0.14**	−0.07*	−0.09*	0.12**	0.09*	−0.10**	0.72**	1.00		
SH3	0.06	0.07	0.13**	0.11**	0.18**	−0.17**	−0.18**	−0.18**	0.15**	0.15**	0.25**	−0.17**	−0.07*	−0.10**	0.14**	0.09*	−0.12**	0.66**	0.86**	1.00	
BE	0.01	0.01	0.09 *	0.08 *	0.12**	−0.25**	−0.23**	−0.24**	0.12**	0.03	0.29**	−0.09 *	−0.04	−0.04	0.34**	0.30**	0.19**	0.28**	0.26**	0.28**	1.00

*p < 0.05; **p < 0.01; ***p < 0.001.

TABLE 4 Evaluation of measurement model (N = 400).

Construct	Observable variable	Standardized loading factor	AVE	CR	Cronbach α
Denial of Responsibility (DR)	DR1	0.720	0.551	0.710	0.756
	DR2	0.764			
Denial of Injury (DI)	DI1	0.842	0.763	0.906	0.905
	DI2	0.896			
	DI3	0.881			
Denial of Victim (DV)	DV1	0.657	0.583	0.806	0.811
	DV2	0.795			
	DV3	0.828			
Defense of Necessity (DN)	DN1	0.763	0.585	0.808	0.805
	DN2	0.836			
	DN3	0.688			
Metaphor of the Ledger (ML)	ML1	0.845	0.736	0.893	0.892
	ML2	0.866			
	ML3	0.863			
Formal Sanction (FS)	FS1	0.754	0.530	0.765	0.750
	FS2	0.861			
	FS3	0.528			
Shame (SH)	SH1	0.744	0.760	0.904	0.898
	SH2	0.966			
	SH3	0.891			
Yielding intention	BE	0.843	0.711	0.711	—

TABLE 5 Fit indices for the tested model.

Fitting indices	χ^2/df	RMSEA	GFI	AGFI	CFI	NFI	IFI	TLI
Recommended value	1–3	≤ 0.08	≥ 0.9	≥ 0.8	≥ 0.9	≥ 0.9	≥ 0.9	≥ 0.9
Tested model	2.60	0.07	0.91	0.88	0.93	0.92	0.93	0.92

only one factor loading (0.53) of observed variable (FS3) is slightly higher than 0.5, but it does not affect the AVE value and CR value of the latent variable (Formal sanction) meeting the requirements. What suggests that both exogenous and endogenous latent variables were adequately assessed and that convergent validity was established.

5.2 Analysis of structural model

The final structural equation model is presented in Figure 2 and Table 6.

The determination coefficient (R^2) for the dependent variable, ‘Yielding intention’, is 0.43. This indicates that model explained 43% of the total variance in yielding intention to pedestrians, suggesting a

commendable level of predictive accuracy and, consequently, model quality (Hair et al., 2014).

Figure 2 illustrates the effects of the five neutralization techniques and two deterrent methods—denial of responsibility, denial of injury, denial of victim, metaphor of the ledger, defense of necessity, formal sanction, and shame—on drivers’ yielding intention to pedestrians. The estimated standardized path coefficients of the Structural Equation Model (SEM) are presented in Table 6. Specifically, denial of injury ($\beta = -0.19$, $p < 0.05$), denial of victim ($\beta = -0.65$, $p < 0.001$), and defense of necessity ($\beta = -0.46$, $p < 0.05$) were found to have a negative relationship with drivers’ yielding intention, supporting Hypothesis 2, Hypothesis 3, and Hypothesis 4. Conversely, formal sanction ($\beta = 0.36$, $p < 0.001$) and shame ($\beta = 0.33$, $p < 0.001$) had a positive relationship with yielding intention, supporting Hypothesis 6 and Hypothesis 7. However, denial of responsibility and metaphor of the ledger did not

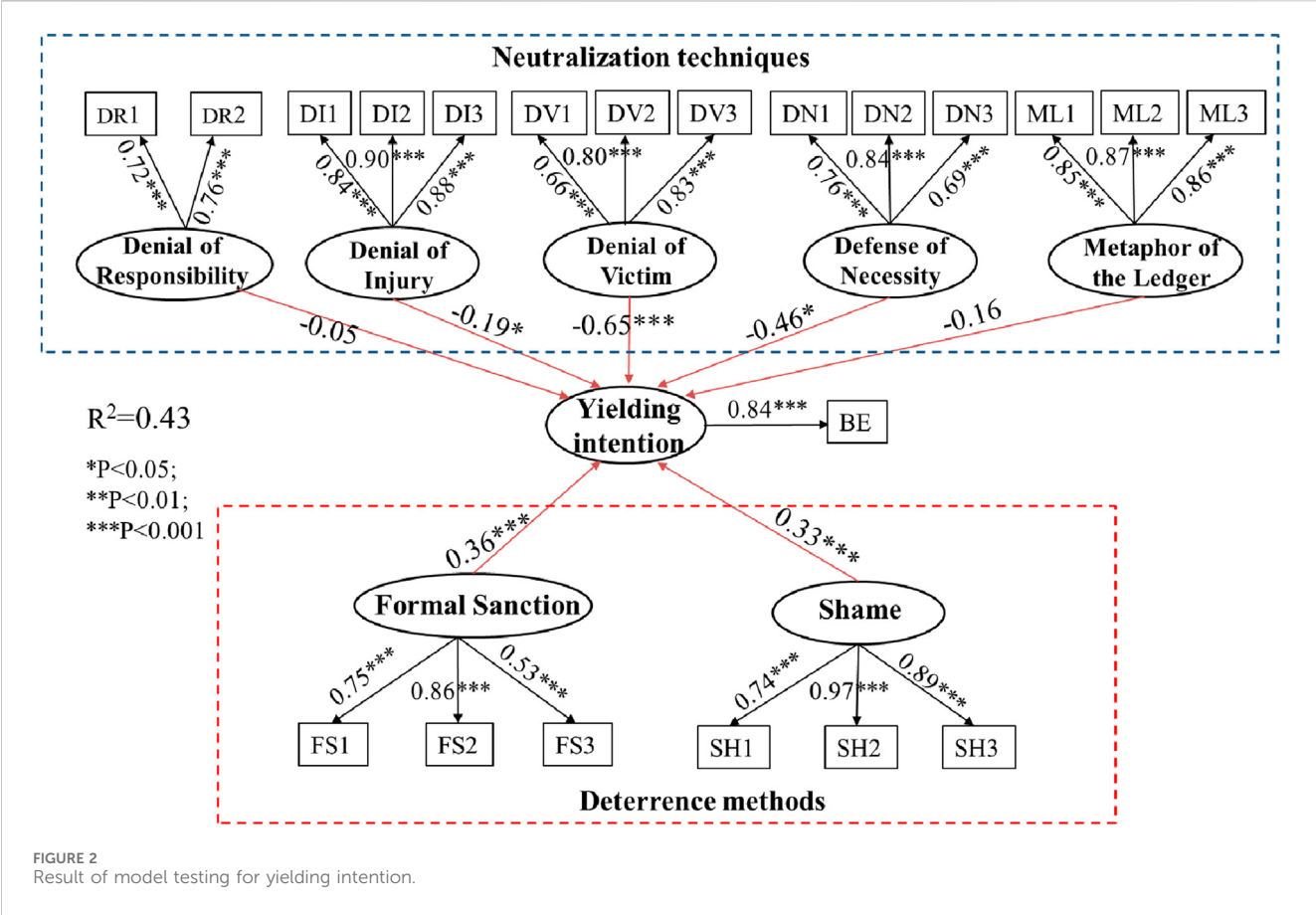


TABLE 6 Standardized loading factor of observable variable.

Hypothesis	Path from hypothesis	Path coefficient	p-values	Significance level	Interpretation
H1	Denial of Responsibility→ Yielding intention	−0.049	0.403	—	Unsupported
H2	Denial of Injury → Yielding intention	−0.186	0.020	0.05	Supported
H3	Denial of Victim → Yielding intention	−0.645	***	0.001	Supported
H4	Defense of Necessity → Yielding intention	−0.460	0.031	0.05	Supported
H5	Metaphor of the Ledger → Yielding intention	−0.157	0.438	—	Unsupported
H6	Formal Sanction → Yielding intention	0.357	***	0.001	Supported
H7	Shame → Yielding intention	0.329	***	0.001	Supported

significantly relate to yielding intention, failing to support Hypothesis 1 and Hypothesis 5.

Path coefficients serve as counterparts to regression weights (Ozorhon and Oral, 2017). A higher path coefficient implies a more pronounced influence of an independent variable on the dependent variable, and the sign (positive/negative) denotes the directionality of the association (Aibinu and Al-Lawati, 2010). Path coefficients falling within the range of 0.1–0.3, 0.3 to 0.5, and 0.5 to 1.0 indicate weak, moderate, and strong influence, respectively (Murari, 2015). In the SEM model, the path coefficient for denial of injury to yielding intention is −0.19, indicating a weak negative influence. The path coefficients for denial of victim to yielding intention is −0.65, respectively, indicating strong

negative influences. The path coefficients for defense of necessity, formal sanction and shame to yielding intention are −0.46, 0.36 and 0.33, respectively, indicating moderate influences.

6 Discussion

6.1 Effects of neutralization techniques on the yielding intention

The results of SEM model also indicate that three neutralization techniques — ‘denial of injury’, ‘denial of victim’, ‘defense of

necessity'—inhibit drivers' yielding intention to pedestrians. As shown in Figure 2, these techniques have significant negative effects on the drivers' yielding intention with path coefficients and p-values as follows: $\beta = -0.19$, $p < 0.05$ for denial of injury; $\beta = -0.65$, $p < 0.01$ for denial of victim; and $\beta = -0.46$, $p < 0.05$ for metaphor of the ledger.

Among all the latent variables, denial of victim has the largest effect. This suggests that an increase in drivers' rejection of pedestrian crossing behavior significantly reduces their yielding attitude and behavior toward pedestrians. Driver's decision-making process regarding whether to yield is largely influenced by pedestrian crossing behavior (Liu et al., 2022). For instance, jaywalkers are less likely to elicit yielding behaviors from drivers (Zheng et al., 2015). When encountering pedestrians' poor crossing behavior, drivers' tolerance decreases, and their tendency to not yield increases (Schneider and Sanders, 2015; Zafri et al., 2022).

In the denial of victim technique, the observed variable DV3 and DV2 (loading factor of 0.83 and 0.80, respectively) are more strongly associated with drivers' perceptions than DV1 (loading factors of 0.66). This indicates that in drivers' psychological cognition, pedestrians crossing the street one after another and jaywalking are considered the worst behavior affecting traffic flow and the most prominent behavior leading to drivers' refusal to yield. Relevant studies show that the faster pedestrians cross the street, the higher the rate of drivers yielding (Dileep et al., 2016).

The results did not reveal a significant relationship between the two neutralization techniques—"Denial of Responsibility" and "Metaphor of the Ledger"—and drivers' yielding intention to pedestrians. This may be attributed to the substantial impact of legal publicity and improvements in the road environment following focused rectification efforts. Additionally, the principle of equality before the law is deeply ingrained in people's minds: regardless of one's status or honor, it cannot offset the nature of the violation.

6.2 Effects of deterrence methods on the yielding intention

The results of the SEM model indicate that the path coefficients for formal sanction and shame on "yielding intention" are significant and roughly equivalent, at 0.36 and 0.33, respectively. This suggests that both deterrent methods effectively promote drivers' intention to yield to pedestrians and that their impact on yielding intention is similar. Although formal penalties for drivers' failure to yield are commonly observed in traffic management, shame are increasingly being implemented by enterprises and community members, enhancing governance effectiveness within the current multi-stakeholder social governance framework. Failure to yield is both a legal and moral violation, prompting drivers to care about others' opinions and experience shame, which positively promotes self-correction (Ugrin and Michael Pearson, 2013).

Regarding formal sanctions, FS2 (loading factor of 0.86) better characterizes the deterrent effect than FS1 (0.75) and FS3 (0.53). This indicates that a 3-point deduction on the driver's license is perceived as a stronger deterrent than a ¥100 fine or traffic duty. In China, accumulating 12 demerit points results in license suspension, significantly impacting future travel. Thus, drivers perceive a 3-point deduction as a greater loss than fines or traffic duty, as it represents a higher cost in the traffic violation calculus (Lee et al., 2018).

Similarly, for shame, SH2 and SH3 (loadings of 0.97 and 0.89, respectively) better characterize the construct than SH4 (0.74). This suggests that drivers are more concerned with the opinions of acquaintances (leaders, colleagues, friends, and family) than with those of strangers. This is because shame is influenced by social distance, with closer relationships eliciting more intense concern and pronounced shame (Riek, 2010).

6.3 The comprehensive effect of neutralization techniques and deterrence theory on the yielding intention

In structural equation modeling (SEM), standardized path coefficients eliminate differences in measurement units, and their absolute values can directly reflect the strength of influence (Hair et al., 2022). This implies that if multiple paths share a consistent theoretical mechanism (e.g., "promoting factors"), the average value of their standardized coefficients can be regarded as the "comprehensive effect" of that mechanism.

The intra-group average standard effect size of neutralization techniques on yielding intention is -0.43 (i.e. $(-0.19 + (-0.65) + (-0.46))/3$), and which the 95% confidence intervals is $[-1.00, 0.14]$. This indicates that motorists use neutralization techniques to psychologically justify their non-yielding behavior, thereby reducing their intention to yield to pedestrians. Neutralization techniques are self-persuasion strategies that individuals employ to maintain a positive self-perception when their behavior deviates from social norms (Cheng et al., 2014; Copes and Maruna, 2018). In the context of traffic behavior, drivers apply these techniques to rationalize their violations of traffic rules, diluting any negative feelings associated with non-compliance.

The intra-group average standard effect size of the deterrence approach on yielding intention is 0.35 ($((0.36 + 0.33)/2)$) and which the 95% confidence intervals is $[0.17, 0.52]$. Penalties imposed on drivers for failing to yield to pedestrians have a significant deterrent effect, increasing the intention to yield. This aligns with the core tenets of deterrence theory (Ugrin and Michael Pearson, 2013). Specifically, non-yielding behavior results in perceived losses for drivers, including economic penalties, demerit points affecting driving qualifications, and time costs. Additionally, it damages the social support and sense of identity drivers receive from their community. These cumulative losses prompt drivers to reduce or cease violations and increase their tendency to yield to pedestrians. The results of the comparison of intra-group average effect sizes show that the absolute value of the average effect size of the neutralization technique group (0.43) is slightly higher than that of the deterrence theory group (0.35). Moreover, there is no overlap between the confidence intervals of the two groups, indicating that the difference reaches a statistically significant level. It means that the comprehensive effect of neutralization techniques on yielding intention to pedestrians is greater in magnitude than that of deterrence methods. Overall, neutralization techniques exert a stronger negative influence on yielding intention than deterrence does. During high-intensity enforcement campaigns, drivers are more aware of and sensitive to penalties, which enhances the deterrent effect against non-yielding and boosts yielding intention. However, when enforcement intensity wanes and the

deterrent effect of current penalties is outweighed by the exculpatory power of neutralization techniques, drivers are more likely to choose not to yield (Wang et al., 2021). This explains why, in many Chinese cities, the yielding rate at zebra crossings dropped to below 35% after high-pressure policies ended in 2018 (Malenje et al., 2019).

7 Conclusions and policy implication

This study investigates the psychological influences of neutralization techniques and deterrence theory on drivers' behavior toward yielding to pedestrians using a structural equation model (SEM). The findings reveal that neutralization techniques—specifically “denial of injury,” “denial of the victim,” and “defense of necessity”—significantly reduce drivers' intention to yield, whereas deterrence methods—“formal sanction” and “shame”—positively promote yielding intention. Notably, the negative impact of neutralization techniques outweighs the positive influence of deterrence methods. Among the variables significantly affecting yielding intention, “denial of the victim” has the strongest effect (coefficient: -0.84), and pedestrians' slow crossing is the most representative behavioral factor. These insights enhance our understanding of drivers' psychological perceptions regarding yielding to pedestrians and provide a basis for designing measures to encourage active yielding, thereby improving pedestrian safety.

Theoretically, this study advances traffic behavior research by applying neutralization and deterrence theories from criminal psychology to dissect the decision-making mechanisms behind drivers' yielding intention. This approach enriches the existing theoretical framework. Practically, the findings offer actionable recommendations to enhance regulatory measures and improve yielding behavior:

- **Standardize Pedestrian Crossing Behavior:** Current policies predominantly penalize drivers for failing to yield, often neglecting the role of pedestrian behavior in shaping drivers' decisions. Strengthening public education and awareness campaigns on traffic rules for pedestrians can curb irregular actions like jaywalking and slow crossing. This, in turn, can reduce drivers' reliance on the “denial of the victim” technique and bolster their intention to yield.
- **Refine Enforcement and Penalty Systems:** The study highlights that penalties tied to driving qualifications (e.g., demerit points) outstrip financial fines in deterrent effect. Enhancing the cumulative points system and integrating shame—such as exposing uncivil driving within social networks—could strengthen deterrence.

While this study leverages empirical data from Wuhan, differences in traffic regulations, road conditions, and socio-cultural contexts may limit the generalizability of the findings. Future research should broaden the sample to include comparative analyses of yielding behavior across diverse cities or countries and assess the long-term efficacy of intervention strategies, providing more robust policy guidance.

Data availability statement

The raw data supporting the findings of this study will be made available by the corresponding author upon reasonable request. Requests to access the datasets should be directed to Chen Yin, yinchen0821@gmail.com.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the patients/participants or patients/participants legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

CY: Software, Writing – original draft, Investigation, Visualization, Validation, Conceptualization. ND: Data curation, Methodology, Writing – original draft. JZ: Methodology, Data curation, Validation, Writing – review and editing. ZS: Funding acquisition, Writing – review and editing, Formal Analysis, Validation, Investigation. CT: Supervision, Software, Writing – review and editing.

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Conflict of interest

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