Japanese Journal of Applied Psychology
2012, Vol. 38 (special edition), 58–67

Article

Influence of Expectation and Cognitive Bias on Cyclists' Crossing Intentions:

An Application of the Theory of Planned Behavior

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This study sought to clarify the influence of cyclists' expectation and cognitive bias on their unsafe crossing intentions. Situations depicting a cyclist about to cross a non-signalized intersection where a car is approaching were presented in questionnaires using the theory of planned behavior (TPB). Each situation was designed with right-of-way, distance to the car, and psychological state of the cyclist. Respondents completed items about intention to cross the intersection, the TPB components, and their expectation and cognitive bias for each situation. After collapsing the psychological state, hierarchical regression analyses for each situation revealed that the TPB components explained a much of the variance in intention. Thus, the TPB can be applied to predict cyclists' unsafe crossing intentions. Furthermore, items about expectation and cognitive bias increased the amount of variance explained. At least one of these induced an unsafe intention in every situation. Therefore, intervention to reduce expectation and cognitive bias may reduce bicycle-related accidents.

Key words: bicycle-related accidents, expectations, cognitive bias, theory of planned behavior

INTRODUCTION

Road traffic statistics from the National Police Agency (2011) indicate that the number of traffic accident fatalities in Japan has been decreasing. It fell below 5000 for the second consecutive year from 2009 to 2010. However, because of the relatively low reduction rate of bicycle-related accident deaths, their component rate among total traffic accident fatalities has been increasing (from 10.85% to 13.53% in the past decade).

Bicycle riding is not only environmentally friendly but also beneficial to the riders' health. In Japan, bicycle riding is very popular, especially for shopping and commuting. Therefore, it is advantageous to determine the cause of bicycle-related accidents and to implement proper intervention.

Cyclists are quite vulnerable on the road; thus, they are expected to behave safely in heavy traffic (e.g., with cars and motorcycles around). However, Japanese accident data in 2010 (National Police Agency, 2011) suggest that cyclists violated traffic laws in more than 65% of bicycle-related accidents. Some studies reported the possibility that cyclists' unsafe behavior is related to their distorted judgment. Räsänen & Summala (1998) reported that when cyclists have the right-of-way at non-signalized intersections, they are likely to expect oncoming cars to yield; such misplaced expectations resulted in bicycle-car collisions. Decision-making and judgment are affected by prior expectations and self-serving interpretations (Taylor & Brown, 1988). Thus, it is possible that expectations and self-serving interpretations are related to bicycle accidents.

Using questionnaires based on the theory of

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planned behavior (TPB) (Ajzen, 1991), this study examined the influence of expectations and self-serving interpretations on cyclists' unsafe intentions to cross non-signalized intersections. The TPB presumes that intention triggers behavior. Intention is further explained by attitude, subjective norm, and perceived behavioral control. Attitude refers to the evaluation of a behavior. Subjective norm is a form of social pressures from important others to commit a particular behavior. Perceived behavioral control reflects how easy an individual believes it is to commit the behavior.

In addition, variables that capture a significant proportion of the variance in intention or behavior can be included in the predictors (Ajzen, 1991). For example, anticipated affect and moral norm explained some variance in drivers' and pedestrians' intention of behavior (e.g., Parker, Manstead, & Stradling, 1995; Zhou & Horrey, 2010). Forward (2009) also verified that descriptive norms and past behavior predict drivers' intentions to violate.

However, as for cyclists' crossing intentions, misplaced expectations deemed as the accident causation by Räsänen & Summala (1998) would be more appropriate predictors than traditional additional variables (e.g., moral norm and past behavior). For example, one additional variable in this study was the expectation that cars would yield (Räsänen & Summala). In addition, two kinds of cognitive bias were adopted as variables involving self-serving interpretations. Self-serving bias is a type of attribution error. According to Miller & Ross (1975), people tend to impute undesirable events to others while attributing desirable events to themselves. Also, unrealistic optimism is an error in judgment. People regard themselves as less vulnerable than other people (Weinstein, 1980). These three concepts are called "bias variables" below.

METHOD

Preliminary study

The risk of traffic behavior depends on traffic situations, yet many previous studies applied the TPB and added variables without presenting concrete situations. Even studies that described situations in detail (e.g., Evans & Norman, 1998; 2003) have limitations in that respondents imagined different situations from text-based scenarios. Thus, preliminary studies were implemented to depict situations precisely in combination with the text and pictures, and to confine the target situations to the typical location of bicycle-related accidents (i.e., non-signalized intersections).

Developing the scenarios Seventeen college students (mean age 21.06, 41.18% male) rated the importance of six events related to college life (classes, end-of-term exams, reports, club activities, part-time jobs, and appointments with friends) by Thurstone's Paired Comparison. End-of-term exams were regarded as the most important events; thus, the scenario in which the cyclist was hastening to an exam was created for a hurrying condition. In contrast, the scenario in which the cyclist was moving toward school for classes in a leisurely manner was considered a calm condition because respondents rated classes as the least important. In both scenarios, the cyclists noticed an approaching car from the right, but tried to cross the intersection without stopping. The right-of-way was also indicated in both scenarios. The car's velocity was not described, since it was assumed to be difficult to imagine velocity based on literal information from the cyclist's viewpoint, regardless of whether or not the respondent had a driving license.

Determining the items and pictures Items of attitude, subjective norm, and perceived behavioral control should be selected by a pilot survey (Ajzen, 1991). For each scenario (condition × right-of-way), 14 college students (mean age 21.14, 35.71% male) described up to three positive and negative results of crossing for attitude, and up to three people who wish and do not wish for them to cross for subjective norm (Table 1). Perceived behavioral control was rated by a single item about perceived ease or difficulty to commit the behavior, along the lines of some studies (e.g., Godin, Valois, Lepage, & Desharnais, 1992; Evans & Norman, 1998).

Next, four panoramic pictures corresponding to the scenarios were presented for each right-of-way. They differed in distance between the cyclist

Table 1. Results of the sub-concepts of items

Variable	Sub-concept	Scenario	Answers
Attitude	Positive result	Hurrying	To be in time for the exam (78.57%)
		Calm	To be in time for the classes (64.29%)
	Negative result	Hurrying	To be involved in accidents (100%)
		Calm	To be involved in accidents (100%)
Subjective norm	Others who wish respondents to cross	Hurrying	Teacher of the exam (50%) and another cyclists coming from behind (21.43%)
		Calm	Teacher of the classes (28.57%) and another cyclists coming from behind (28.57%)
	Others who do not wish respondents to cross	Hurrying	Parents and drivers (78.57%)
		Calm	Parents and drivers (78.57%)

Note: The percentages of respondents for each answer are in parentheses.
The right-of-way turned out to be without reference to answers.

Table 2. Results of picture selection

	Major-Far (9 m)	Major-Near (6.5 m)	Minor-Far (24 m)	Minor-Near (16 m)
Intention	3.93 (1.73)	2.57 (1.83)	4.29 (1.77)	2.43 (1.45)
t-Test	$t[13]=6.03$, $p<.001$		$t[13]=5.64$, $p<.001$	

Note: Standard deviations are in parentheses.

and the oncoming car (major roads: 4 m, 6.5 m, 9 m, 11.5 m; minor roads: 8 m, 16 m, 24 m, 32 m). Respondents rated intentions to cross the intersection for each picture on a seven-point scale (1: very weakly to 7: very strongly). Results indicated the floor and ceiling effects for the nearest and the farthest pictures; thus, the remaining two pictures for each right-of-way were selected. Actual and apparent distances differed in the panoramic pictures; however, paired *t*-tests guaranteed that respondents recognized the relative difference between the two pictures for each right-of-way (Table 2).

Respondents

Questionnaires were distributed to students at four universities and one college (collection rate 95.19%). After removing 14 respondents' data that included missing values, the responses of 184 respondents (46.74% males) were deemed valid. The group's mean age was 21.52 ($SD=2.49$, range $=19$ to 30), and 61.96% of them held automobile or motorcycle driving licenses or both. Of these respondents, 60.33% used their bicycles at least once a week.

Procedure and design of the questionnaire

Respondents were instructed to imagine the situation depicted by a scenario and a picture (e.g., Figs. 1 and 2). Based on preliminary studies, eight situations were designed with three factors: right-of-way (cyclist moving on a major or minor road), distance (far from or near the car on the crossroad), and psychological state (the scenario of a hurrying condition or a calm condition).

The only between-participants factor was psychological state, so each questionnaire contained four situations. Either a questionnaire for the hurrying condition or one for the calm condition was randomly delivered.

Measures

For each situation, respondents answered 17 items about intention, the TPB components (atti-

Fig. 1. Major-Near situation

Fig. 2. Minor-Far situation

tude, subjective norm, and perceived behavioral control), and additional bias variables (expectation that cars would yield, self-serving bias, and unrealistic optimism) on a seven-point scale.

Intention Intention was rated by how much respondents wanted to cross the intersection as depicted (1: very weakly to 7: very strongly).

TPB components Four items focused on attitude. Two were related to behavioral beliefs regarding the likelihood of the results (involvement in an accident and getting to school earlier) of crossing in the scenarios (1: very unlikely to 7: very likely). The other two were about the evaluation of each result described above (1: very bad to 7: very good). The products of the behavioral belief and its evaluation for each result were averaged and defined as the attitude score.

Eight items were related to subjective norms. Four involved normative beliefs. Respondents were to imagine how much their important others would want them to cross (1: very weakly to 7: very strongly). The other four were about motivation to comply with the wishes of their important others (1: very weakly to 7: very strongly). The products of the normative beliefs and the motivation to comply were calculated for each important other (parent, driver, another cyclist coming from behind, and the teacher of the exam or class). The average of the products was defined as the subjective norm score.

Perceived behavioral control involved the degree of difficulty of crossing the road as depicted in the scenario (1: very difficult to 7: very easy). For ease of answering, this variable was measured by a single item.

Bias variables Each of the three bias variables was rated using a single item. For the expectation that cars would yield, respondents were asked how strongly they expected the automobile driver to yield in each situation (1: not at all to 7: a great deal). For the item of self-serving bias, respondents imagined their own responsibility in an accident as a result of crossing (1: a great deal to 7: not at all). As for unrealistic optimism, respondents rated the possibility of their being involved in an accident compared to that possibility for average students of the same generation (1: very unlikely to 7: very likely). Only unrealistic optimism was measured with an inverted scale; thus, the rated score was reversed so that higher scores could mean riskier values.

These variables are considered bias variables, because previous studies indicated that people as a group generally exhibit these biased cognitions (Räsänen & Summala, 1998; Miller & Ross, 1975; Weinstein, 1980). However, this study examined the effects of bias variables on intention at the individual level; thus, respondents with higher scores of bias variables were regarded as having stronger biased cognition.

Analysis

Intention is a trigger of behavior in the TPB; thus, it is necessary to check whether each of the three factors influenced intention or not. A three-way repeated measures analysis of variance (right-of-way × distance × psychological state), with intention as the dependent variable, was conducted.

Next, hierarchical regression analyses with intention as the dependent variable were performed for each situation. The independent variables were divided into three steps. In step one, four demographic variables (age, gender, with or without a driving license, and with or without the use of a bicycle) were entered. These demographic variables, except for age, were converted to categorical data (male = 1, female = 0; with a driving license = 1, without a driving license = 0; with the use of a bicycle = 1, without the use of a bicycle = 0). In step two, the TPB components were added. In step three, bias variables were determined for the independent variables. For each step, independent

Table 3. Descriptive statistics of variables

	Major-Far		Major-Near		Minor-Far		Minor-Near	
Variables (Range)	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Intention (1–7)	4.61	1.98	4.00	2.14	3.24	2.17	2.28	1.69
Attitude (1–49)	14.07	5.28	13.41	5.37	13.60	5.56	13.06	5.45
Subjective norm (1–49)	13.59	7.61	12.50	6.64	10.94	6.19	8.67	4.19
Perceived behavioral control (1–7)	4.82	1.60	4.17	1.79	3.55	1.86	2.85	1.60
Expectation that cars would yield (1–7)	5.34	1.42	4.81	1.75	3.65	2.12	2.82	1.75
Self-serving bias (1–7)	4.80	1.51	4.41	1.75.	3.28	1.56	2.93	1.56
Unrealistic optimism (1–7)	4.25	1.53	3.98	1.58	3.60	1.67	3.19	1.63

variables were entered by the stepwise method.

Regarding the numerical items among independent variables, higher scores indicated stronger unsafe intentions.

RESULTS

Constructing situations

Results of a three-way repeated measures analysis of variance indicated that the interaction of right-of-way and distance was significant ($F[1, 182]=4.29$, $p<.05$). The post-hoc test revealed that intentions were stronger when the approaching car was farther away, regardless of right-of-way ($ps<.001$). Also, regardless of distance, respondents had stronger intentions to cross when cycling on a major road than when cycling on a minor road ($ps<.001$). However, the psychological state did not affect intention.

Predicting crossing intentions

Following the analysis of variance, the psychological state was collapsed, and four situations were redesigned with right-of-way and distance. Means and standard deviations for all variables are presented in Table 3. Hierarchical regression analyses were performed for each situation. The correlation coefficients between variables are presented in Table 4. The results of the hierarchical regression analyses are indicated below for each situation.

Major-Far situation As presented in Table 5, only the effect of gender was significant in step one. Males were likely to cross the intersection when they were moving on a major road and an oncoming car was distant. In steps two and three, subjective norm and perceived behavioral control became significant predictors of intention. Also in step three, the expectation that cars would yield had a significant effect. A higher expectation that cars would yield induced an unsafe intention to cross. For each step, the increased proportion of variance explained (ΔR^2) was significant.

Major-Near situation As presented in Table 5, respondents who had driving licenses tended to cross the intersection when they were moving on a major road and an oncoming car was close in step one. In step two, subjective norm and perceived behavioral control became significant predictors of intention. However, in step three, the effect of subjective norm disappeared, while the effects of self-serving bias and unrealistic optimism became significant. They induced unsafe intentions to cross the intersection in a major-near situation. For each step, the increased proportion of variance explained (ΔR^2) was significant.

Minor-Far situation As presented in Table 5, the effects of age and gender were significant in step one. Younger or male respondents tended to cross the intersection when they were moving on a minor road and the oncoming car was distant. In step two, gender and all TPB components were predictors of intention. In step three, the effect of subjective norm disappeared, but the expectation that cars would yield additionally promoted unsafe intentions. Also, the effect of gender remained significant in step three. For each step, the increased proportion of variance explained (ΔR^2) was significant.

Minor-Near situation As presented in Table 5, with or without a driving license and the use of a bicycle became significant predictors in step one. Respondents who do not hold a driving license or

Table 4. Correlation coefficients between variables

Major-Far										
	INT	AGE	GEN	DL	UB	ATT	SN	PBC	EXP	SSB
AGE	−.08	—	—	—	—	—	—	—	—	—
GEN	.16*	.28***	—	—	—	—	—	—	—	—
DL	.12	.40***	.29***	—	—	—	—	—	—	—
UB	.02	−.23**	.03	−.09	—	—	—	—	—	—
ATT	.15*	−.15*	−.07	−.15*	−.02	—	—	—	—	—
SN	.43***	−.05	.15*	.04	−.02	.24**	—	—	—	—
PBC	.70***	.02	.20**	.16*	−.01	.10	.36***	—	—	—
EXP	.56***	−.06	−.02	.04	.02	.16*	.37***	.42***	—	—
SSB	.42***	.07	.20**	.23**	−.01	.14*	.36***	.40***	.40***	—
UO	.41***	−.08	.10	.01	.01	.04	.28***	.41***	.39***	.33***
Major-Near										
	INT	AGE	GEN	DL	UB	ATT	SN	PBC	EXP	SSB
AGE	.01	—	—	—	—	—	—	—	—	—
GEN	.13*	.28***	—	—	—	—	—	—	—	—
DL	.20**	.40***	.29***	—	—	—	—	—	—	—
UB	.06	−.23**	.03	−.09	—	—	—	—	—	—
ATT	.23**	−.12	−.12	−.14*	−.10	—	—	—	—	—
SN	.47***	−.05	.10	.10	−.00	.27***	—	—	—	—
PBC	.74***	.04	.15*	.15*	.06	.27***	.48***	—	—	—
EXP	.55***	−.00	.03	.05	.08	.06	.37***	.62***	—	—
SSB	.60***	.03	.17*	.22**	.03	.16*	.36***	.58***	.49***	—
UO	.47***	−.06	.13*	.06	.03	.25***	.32***	.43***	.34***	.45***
Minor-Far										
	INT	AGE	GEN	DL	UB	ATT	SN	PBC	EXP	SSB
AGE	−.22**	—	—	—	—	—	—	—	—	—
GEN	.09	.28***	—	—	—	—	—	—	—	—
DL	−.16*	.40***	.29***	—	—	—	—	—	—	—
UB	−.01	−.23**	.03	−.09	—	—	—	—	—	—
ATT	.31***	−.15*	−.07	−.14*	−.12	—	—	—	—	—
SN	.44***	−.14*	−.01	−.19**	−.10	.32***	—	—	—	—
PBC	.75***	−.20**	.02	−.23**	−.01	.25***	.42***	—	—	—
EXP	.60***	−.22**	−.02	−.28***	−.06	.17*	.44***	.64***	—	—
SSB	.53***	−.11	.01	−.18**	−.07	.27***	.44***	.57***	.53***	—
UO	.42***	−.11	.06	−.11	.02	.03	.32***	.45***	.37***	.37***
Minor-Near										
	INT	AGE	GEN	DL	UB	ATT	SN	PBC	EXP	SSB
AGE	−.15*	—	—	—	—	—	—	—	—	—
GEN	.05	.28***	—	—	—	—	—	—	—	—
DL	−.18**	.40***	.29***	—	—	—	—	—	—	—
UB	−.16*	−.23**	.03	−.09	—	—	—	—	—	—
ATT	.30***	−.20**	−.11	−.18**	−.06	—	—	—	—	—
SN	.34***	−.15*	−.01	−.15*	−.14*	.20**	—	—	—	—
PBC	.64***	−.15*	.04	−.17*	−.12	.24***	.23**	—	—	—
EXP	.37***	−.19**	−.10	−.30***	−.04	.15*	.12	.38***	—	—
SSB	.34***	−.19**	.02	−.12	−.03	.19**	.20**	.38***	.32***	—
UO	.41***	−.13*	.10	−.18**	−.01	.18**	.27***	.34***	.20**	.30***

Note: INT=Intention, AGE=Age, GEN=Gender, DL=Driving License, UB=Use of a bicycle, ATT=Attitude, SN=Subjective norm, PBC=Perceived behavioral control, EXP=Expectation that cars would yield, SSB=Self-serving bias, UO=Unrealistic optimism.
***$p<.001$, **$p<.01$, *$p<.05$.

Table 5. Results of hierarchical regression analyses

Major-Far						
Step	Independent variables	$\beta 1$	$\beta 2$	$\beta 3$	Adj R^2	ΔR^2
1	Age					
	Gender	.16*			.02	
	Driving license					
	Use of a bicycle					
2	Attitude					
	Subjective norm		.20***	.13*	.51	.49***
	Preceived behavioral control		.62***	.52***		
3	Expectation that cars would yield			.30***		
	Self-serving bias				.58	.07***
	Unrealistic optimism					
Major-Near						
Step	Independent variables	$\beta 1$	$\beta 2$	$\beta 3$	Adj R^2	ΔR^2
1	Age					
	Gender				.04	
	Driving license	.20**				
	Use of a bicycle					
2	Attitude					
	Subjective norm		.14*		.57	.53***
	Preceived behavioral control		.66***	.52***		
3	Expectation that cars would yield					
	Self-serving bias			.19**	.61	.04***
	Unrealistic optimism			.13*		
Minor-Far						
Step	Independent variables	$\beta 1$	$\beta 2$	$\beta 3$	Adj R^2	ΔR^2
1	Age	−.27***				
	Gender	.16*	.11*	.11*	.06	
	Driving license					
	Use of a bicycle					
2	Attitude		.11*	.12*		
	Subjective norm		.13*		.60	.53***
	Preceived behavioral control		.65***	.55***		
3	Expectation that cars would yield			.18**		
	Self-serving bias				.61	.02***
	Unrealistic optimism					
Minor-Near						
Step	Independent variables	$\beta 1$	$\beta 2$	$\beta 3$	Adj R^2	ΔR^2
1	Age					
	Gender				.06	
	Driving license	−.20**				
	Use of a bicycle	−.20*				
2	Attitude		.12*			
	Subjective norm		.18**	.14*	.46	.40***
	Preceived behavioral control		.55***	.47***		
3	Expectation that cars would yield			.13*		
	Self-serving bias				.49	.03***
	Unrealistic optimism			.17**		

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

β: standardized partial regression coefficient at each step.

Adj R^2: adjusted coefficient of determination.

ΔR^2: change of R^2.

do not use a bicycle are apt to have unsafe intentions to cross. In step two, all the TPB components significantly induced intention. However, only the effect of attitude diminished in step three. By way of compensation, the expectation that cars would yield and unrealistic optimism promoted intention in step three. For each step, the increased proportion of variance explained (ΔR^2) was significant.

DISCUSSION

Constructing situations

A three-way analysis of variance indicated that psychological state had little effect on intention. The same analysis confirmed the interaction between right-of-way and distance. Thus, given the minor effect of psychological state, constructing four situations with the remaining two factors should better emphasize the differences among situations.

Predicting crossing intentions

Step one Some of the respondents' attributes were significant predictors in each situation. Interestingly, when cyclists travel on a major road, driving license holders have stronger intentions to cross even when the distance from the car is the shortest (major-near: 6.5 m). Meanwhile, the distance is greater in a minor-near situation (16 m), but they refrain from crossing. This result indicates that driving license holders' intentions correspond to traffic laws. Obeying the right-of-way makes cyclists safer because cars on a major crossroad (i.e., cyclists are on a minor road) generally approach faster; therefore, even if the distance is greater, time-to-collision tends to be shorter and the accident probability is higher.

However, the amount of variance explained in intention was so low (R^2=.02 to .06) that the models in step one were inappropriate.

Step two The TPB components could explain the high percentages in the variance in intention (R^2=.46 to .60), after controlling for the effect of demographic variables. The percentages of variance explained are higher than those in other studies that apply the TPB to pedestrians' unsafe crossing (e.g., Evans & Norman, 1998; 2003). Thus, the predictive utility of the TPB for cyclists' unsafe crossing behavior is suggested.

Among the TPB components, perceived behavioral control promoted unsafe intentions in all situations. Regardless of right-of-way and distance to the approaching car, feeling that it would be easy to cross potentially hazardous intersections was quite dangerous. Conversely, the effects that attitude and subjective norm promoted unsafe intentions were limited in some situations. As suggested by Ajzen (2006), important others generally disapprove of undesirable behavior. The situations in this study were much riskier than those in previous studies. The smaller effect of subjective norm was thus reasonable. Similarly, the effect of attitude was not expected to be strong because the evaluation of riskier crossing behavior should be low.

Step three With the addition of bias variables, the amount of variance explained in intention significantly increased (ΔR^2=.02 to .07) in all situations. According to the TPB, the TPB components are supposed to explain most of the variance in intention in step two. Thus, although the increases of R^2 from step two to step three were quite low, they indicated that bias variables were important predictors of unsafe crossing intentions, which the TPB components could not explain. Furthermore, when bias variables were added, the effects of attitude and subjective norm became insignificant in some situations. This result implies that the influence of bias variables on unsafe crossing intentions is stronger than that of attitude and subjective norm when a car is approaching a non-signalized intersection.

The results of this study support the findings of previous research. Decision-making and judgment are influenced by expectations and self-serving interpretation (Taylor & Brown, 1988). This study examined the effects of bias variables on intention as an alternative concept of decision-making and judgment. The results demonstrate that cyclists' crossing intentions when a car is approaching non-signalized intersections are unsafely distorted by expectation and cognitive bias.

The independent effect of each bias variable is discussed in the following part. First, according to

Räsänen & Summala (1998), cyclists possessing the right-of-way at non-signalized intersections tend to expect oncoming cars to yield. However, in this study, the expectation that cars would yield invoked unsafe intentions even when the cyclist was moving on a minor road. Also, the expectation that cars would yield did not trigger unsafe intentions when the oncoming car was close, even when the cyclist was moving on a major road. Thus, whether the expectation that cars would yield induces unsafe intentions depends more on distance to the approaching car than on right-of-way. In the major-near situation, the physical distance to the oncoming car was the shortest (6.5 m). It is assumed that the car did not have enough room to take evasive action (e.g., halt or slow down) in the major-near situation.

Second, the influences of self-serving bias and unrealistic optimism rose in situations where the expectation that cars would yield had little effect. Among the three situations in which the expectation that the car would yield promoted unsafe intentions, its power was the weakest in the minor-near situation ($\beta = .13$). In this situation, unrealistic optimism triggered unsafe intentions as well. Also, as mentioned above, the expectation that cars would yield did not influence intention in the major-near situation. In this situation, both unrealistic optimism and self-serving bias induced unsafe intentions. These results suggest that at least one bias variable (i.e., expectation that cars would yield, self-serving bias, or unrealistic optimism) acted on unsafe intention in a complementary style.

CONCLUSION

This study confirmed the predictive usefulness of the TPB for cyclists' unsafe crossing intentions. Traditionally, previous studies that applied the TPB to predict cyclists' intentions focused mainly on helmet usage (e.g., Farley, Haddad, & Brown, 1996; Quine, Rutter, & Arnold, 2001). Wearing a helmet may lessen the severity of injuries; thus, it should be encouraged more. However, helmets cannot prevent accidents. Predicting cyclists' crossing intentions using the TPB may resolve the mechanism of cyclists' unsafe behavior and clarify the causes of bicycle-related accidents from various viewpoints.

Furthermore, incentives for unsafe crossing intentions were revealed. Even when it was clear that a car was approaching, certain kinds of expectation and cognitive bias promoted unsafe crossing intentions. It is particularly noteworthy that, in contrast with the findings of Räsänen & Summala (1998), the influence of the expectation that cars would yield may not be limited to situations in which cyclists have the right-of-way. Similarly, self-serving bias and unrealistic optimism induced unsafe intentions when the influence of the expectation that cars would yield was weak. This finding indicates the importance of considering cyclists' expectations and self-serving interpretations in predicting their unsafe intentions. Consequently, educational intervention to lower these factors could repress cyclists' unsafe behavior.

Future study is necessary to ascertain whether the intention predicted by the TPB components and bias variables is linked to actual behavior.

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