

# The influences of cognitive appraisal, physical injury, coping strategy, and forgiveness of others on PTSD symptoms in traffic accidents using hierarchical linear modeling

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## Abstract

The purpose of this study was to identify how physical injury, perceived threat, forgiveness of others, and problem-focused coping influence the change of posttraumatic stress disorder (PTSD) symptoms. One hundred twenty patients who had experienced a traumatic vehicle accident participated in 1 to 2 months after the accident; 70 of these people involved at 6 months after the accident. We used a hierarchical linear model analysis to verify the impacts of predictors on change of PTSD symptoms as time passed. The results showed that PTSD symptoms decreased over time, and greater perceived threat would worsen PTSD symptoms and more forgiveness would decrease PTSD symptoms. On the other hand problem-focused coping and physical injury severity were not significantly related to the PTSD symptoms. Specifically, greater perceived threat was found to be related with a deceleration of the decrease in PTSD symptoms, whereas greater forgiveness of others was associated with an acceleration of this decrease. However, problem-focused coping and physical injury severity had no influence on the change rate of PTSD symptoms. Cognitive variable could be more important than physical injury to understand PTSD. In addition, forgiveness of other in a traumatic situation needs to be considered as one of coping strategies.

**Abbreviations:** DSM = Diagnostic and Statistical Manual of Mental Disorders, EFI = Enright Forgiveness Inventory, HLM = hierarchical linear modeling, IES = Impact of Event Scale, ISS = Injury Severity Scale, PTSD = posttraumatic stress disorder, WCC = Ways of Coping Checklist.

**Keywords:** forgiveness of others, hierarchical linear model, perceived threat, physical injury, problem-focused coping, PTSD

## 1. Introduction

The impacts of cognitive appraisals and coping strategies on posttraumatic stress disorder (PTSD) have been extensively examined by researchers. However, previous studies have mainly verified the effects of predictors of PTSD symptoms among veterans or victims of interpersonal violence; few focused on individuals who have experienced traffic accidents which are much more common in daily life compared with other types of traumatic events.

Perceived threat occurs when one feels the threat of death or physical injury during or immediately after a traumatic event, which is a representative cognitive variable related to traumatic

event. Olff et al<sup>[1]</sup> proposed that the cognitive appraisal of trauma is a core factor leading to various psychobiological responses to trauma. Actually, the impact of perceived threat on PTSD was found in various types of trauma such as interpersonal violence, fire incident, and warzone deployment.<sup>[2–4]</sup> However, studies of patients who had a traffic accident were a few, which limits the generalization of the results.

Many people wounded in traumatic events, which may affect mental health of patients. However, relationship between physical injury severity and PTSD is not clear. Some studies have reported that physical injury severity is related to PTSD symptoms,<sup>[5–7]</sup> whereas other studies have proposed that physical injury is not associated with PTSD.<sup>[7,8]</sup> Thus, we need to verify the independent influence of this variable on PTSD in longitudinal design study.

The influence of problem-focused coping on PTSD is ambiguous. Some studies found that problem-focused coping was a significant predictor of PTSD.<sup>[9–11]</sup> However, findings from other studies did not indicate a statistically significant relationship between the 2 variables.<sup>[12–15]</sup> Recently, several longitudinal studies have shown that problem-focused coping influences PTSD symptoms.<sup>[16,17]</sup> However, little is known about the influence of problem-focused coping on PTSD among victims of vehicle accidents.

Olff et al<sup>[1]</sup> emphasized that cognitive appraisal and coping are core factors of the development of PTSD. Also, they suggested that other aspects of coping strategies should be considered to better understand how PTSD develops. Strelan and Covic<sup>[18]</sup> proposed that forgiveness might be a type of coping strategy that deals with stress or trauma, and the number of studies that

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consider this has been increasing since 2000. Especially, forgiveness of others is that the victim exhibits a decrease in negative emotions such as anger and disgust against the attacker or opponent and show mercy to the opponent.<sup>[19]</sup>

Some studies identified that forgiveness of others (opponent at fault or attacker) would decrease PTSD symptoms.<sup>[20–22]</sup> More importantly, it should be regarded as a process that is composed of specific stages such as impact (confronting uncomfortable feelings), search for meaning, and recovery.<sup>[23]</sup> Therefore, the process of forgiveness should be identified over time to better understand the effect of forgiveness on PTSD. However, most studies assessed forgiveness at a single point in time.

Other important issue is that it is necessary to examine the impact of forgiveness in unintentional damage situations (e.g., vehicle accidents) to generalize the role of forgiveness to various types of trauma. Identifying the relative influence of forgiveness on PTSD compared with cognitive appraisals and coping strategies may be meaningful efforts in understanding a process of recovery for patients who suffered trauma.

The purpose of this study was to find how perceived threat, physical injury, problem-focused coping, and forgiveness of others influence the change of PTSD symptoms in a longitudinal view.

## 2. Methods

### 2.1. Procedure

The subjects were those who volunteered for research among the patients being treated by traffic accidents at 3 university hospitals. Patients with an ISS scored <1 were excluded from the study. Assessment of PTSD symptoms and a questionnaire were administered to outpatients and inpatients at 1 to 2 months after a traffic accident (time 1) and at 6 months after a vehicle accident (time 2). Participants have been treated in the psychiatry and orthopedics units of 3 university hospitals, 1 of which was a university hospital in Seoul and 2 of which were in the Gyeonggi province. We explained the process of study to all subjects and received their written consent. Patients with clear brain damage were excluded from this study. IRB of Ilsan Paik Hospital approved our study.

### 2.2. Participants

The participants were 18 years of age or older and 120 subjects were involved in the initial assessment (mean elapsed time after traffic accident=49.94 days, SD=24.00 days). Of 120 patients (men: 71, women: 49), 70 people (men: 38, women: 32) were also participated in the second assessment (mean elapsed time after traffic accident=190.90 days, SD=26.33 days). Fifty participants were excluded in the second assessment due to reoperation, worsening of symptoms, and refusal of self-report. Mean age of subjects was 39.83 years (SD=13.67). Physical injury severity was measured by Injury Severity Scale (ISS). Mean of ISS was 3.34 and SD was 1.97.

### 2.3. Measures

**2.3.1. Impact of Event Scale-Revised.** We used the Impact of Event Scale-Revised, Korean version (IES-R-K) that Eun et al<sup>[24]</sup> adapted and validated, sourced from the IES-R of Weiss and Marmar<sup>[25]</sup> to assess PTSD symptoms. This scale, comprising a total 22 questions on 5-point scales, consists of 8 reexperience, 8 avoidance, and 6 hypervigilance items. The Cronbach alpha value was high at 0.96.

**2.3.2. Perceived threat scale.** This scale consists of 5 questions, which we revised with reference to Joo's checklist for posttraumatic crisis.<sup>[26]</sup> This scale measures the level of threat and fear of physical injury and death at the time of accident or immediately after a trauma ("I had thought that I might die at the time of the accident or immediately following the traumatic event," "Did you feel fear or threat at the time of the accident or immediately after trauma?"). The Cronbach alpha value for this was 0.89.

**2.3.3. The ISS.** The ISS was used to assess the physical injury severity of trauma patients. This scale was developed from Baker's Abbreviated Injury Scale.<sup>[27]</sup> Physical injury was rated in 7 areas [e.g., external, head (including face), neck, chest, abdomen or pelvic contents, and extremities or pelvic girdle] of our bodies. Items are measured on a 5-point scale.

**2.3.4. The Ways of Coping Checklist.** We used 22 items corresponding to the problem-focused coping among Kim's scale<sup>[28]</sup> (62 items; 4-point) that adapted Ways of Coping Checklist (WCC).<sup>[29]</sup> The more the score is high, the more the tendency of problem-focused coping strategy (e.g., "I look for concrete solutions to resolve the problem") is strong. The Cronbach alpha value was 0.85.

**2.3.5. Forgiveness of others.** We used Oh's scale<sup>[30]</sup> which adapted Enright's EFI (Enright Forgiveness Inventory)<sup>[19]</sup> to the Korean context. This assesses the degree of forgiveness of victim against the perpetrator or opponent at fault and consists of 24 items on 5-point. The Cronbach alpha value was 0.91. Examples of items were as follows: "The person (perpetrator or opponent at fault) is also human and therefore can make mistakes, I think that the person is a nice man."

### 2.4. Analysis

Our study utilized the hierarchical linear models (HLM) analysis to examine the change of PTSD symptoms over time and the effects of predictive factors on rate of change of PTSD symptoms. HLM is composed of the unconditioned and conditioned model. The former estimates the individual difference in rate of change of PTSD symptoms over time. The latter identify the effects of independent variables (perceived threat, physical injury severity, problem-focused coping, forgiveness) on rate of change of PTSD symptoms. All subjects have an intercept and slope value. The intercept means the initial value of PTSD symptoms at time 1 and slope indicates the change rate of PTSD symptoms. We used the HLM 7.0 (Scientific Software International, Inc.). And, missing data were included in this study because HLM can analyze incomplete data.<sup>[31]</sup>

Unconditional model

$$\text{PTSD symptoms} = \pi_{0i} + \pi_{1i} \text{time} + e$$

Conditional model

$$\pi_{0i} = \beta_{00} + \beta_{01}$$

Perceived threat in first year + $\beta_{02}$ ; physical injury severity in first year + $\beta_{03}$ ; problem-focused coping in first year + $\beta_{04}$ ; forgiveness of others in first year.

$$\pi_{1i} = \beta_{10} + \beta_{11}$$

Perceived threat in first year + $\beta_{12}$ ; physical injury severity in first year + $\beta_{13}$ ; problem-focused coping in first year + $\beta_{14}$ ; forgiveness of others in first year.

**Table 1**  
Mean and SD for variables.

Variable	Time	Frequency	Mean	SD
PTSD symptoms	First	120	25.67	20.15
	Second	70	23.21	16.53
Perceived threat	First	120	15.24 (min=5, max=25)	5.85
Forgiveness of others	First	120	64.50 (min=28, max=105)	19.56
Problem-focused coping	First	120	32.93 (min=15, max=54)	8.80
Physical injury severity	First	120	3.36 (min=1, max=11)	1.98

PTSD = posttraumatic stress disorder.

### 3. Results

#### 3.1. Unconditioned Model

Tables 1 and 2 depicts the intercept of the fixed effect (which indicates the mean of PTSD symptoms at time 1) and the rate of change of the fixed effect (which indicates the mean within-individual rate of change of PTSD symptoms over time).

The mean initial value and rate of change were 25.06 and -4.30, and the intercept and mean of the slope were statistically significant. These results indicate that the mean of PTSD symptoms at time 1 was 25.06 and significantly decreased as time passed. The random effect of the intercept in Table 2 was statistically significant. However, the random effect of change rate was not significant. These results indicate that there is a significant difference between PTSD symptoms of individuals at time 1, whereas there is no individual difference on the rate of change of PTSD symptoms over time.

#### 3.2. Conditioned Model

The conditioned model added the independent variables to explain the impacts of predictors on mean change rate of PTSD symptoms. The results of the analysis are presented in Table 3. Perceived threat had a positive influence on the initial value of PTSD symptoms, whereas forgiveness had a negative impact on the initial value of PTSD symptoms. However, physical injury severity and problem-focused coping did not affect the initial value of PTSD symptoms. These results mean that greater perceived threat at the time 1 was related to greater PTSD symptoms at that time. In contrast, more forgiveness of others was associated with lower PTSD symptoms.

More importantly, greater perceived threat was related to a deceleration of the decrease in PTSD symptoms, whereas greater forgiveness was associated with an acceleration of the decrease in PTSD symptoms. However, physical injury severity and problem-

**Table 2**  
Individual differences in changes of PTSD (unconditioned linear model).

Fixed effect	Estimate	SE	T
Intercept	25.06	1.78	14.18***
Mean of slope/rate of change	-4.30	1.68	-2.56*
Random effect	Estimate	SE	T
Individual difference of initial value	271.75	16.48	355.57***
Individual difference of slope	23.00	4.80	67.71

\*  $P < .05$

\*\*\*  $P < .001$ .

**Table 3**  
The effects of independent variables on PTSD (conditioned linear model).

Fixed effect	Estimate	SE	T (sig.)
Initial value			
Intercept	25.17	1.11	22.71***
Perceived threat	1.66	0.22	7.66***
Forgiveness of others	-0.30	0.07	-4.39***
Problem-focused coping	0.12	0.13	0.94
Physical injury severity	0.75	0.68	1.12
Slope/rate of change			
Intercept	-5.07	1.44	-3.51**
Perceived threat	-0.64	0.22	-2.95**
Forgiveness of others	0.28	0.10	2.88**
Problem-focused coping	-0.23	0.14	-1.61
Physical injury severity	1.65	1.18	1.40

\*\*  $P < .01$

\*\*\*  $P < .001$ .

focused coping did not have an influence on change rate of PTSD symptoms.

### 4. Discussion

The purpose of this study was to explore how physical injury, perceived threat, forgiveness, and problem-focused coping influence the change of PTSD symptoms after a traffic accident. The results showed that PTSD symptoms decreased as time passed. Perceived threat and forgiveness of others had significant impacts on the initial value and change rate of the PTSD symptoms. However, problem-focused coping and physical injury severity did not have an influence on the initial value and change rate of PTSD symptoms. The discussion of the main results was as follows.

Greater perceived threat was associated with more severe PTSD symptoms and a deceleration in the decrease of PTSD symptoms as time passed. The results suggest that decreasing the degree of perceived threat after trauma is exceedingly important in therapeutic interventions. Perceived threat is related to the subjective interpretation of traumatic experience, and is one of the 2 main criteria of trauma exposure in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5).<sup>[32]</sup> In addition, perceived threat is associated with various factors such as personality and history of trauma.<sup>[3]</sup> Thus, therapists need to explore the factors related to perceived threat in therapeutic interventions for patients with PTSD.

Although physical injury severity may be important in the development of PTSD, more empirical evidences are needed before they can be considered as the direct cause of PTSD. The results of this study indicate that perceived threat is more important in the diagnosis and prediction of PTSD onset than physical injury severity, which coincides with Lazarus and Folkman's<sup>[33]</sup> view that cognitive appraisal is more important than the stressor itself when predicting mental health after stress.

Researchers should thoroughly explore the impact of physical injury on PTSD in future studies. In most studies, the data for physical injury severity did not meet the assumption of normality, which might influence the strength of the relationship of physical injury and PTSD symptoms. In addition, researchers need to explore differences in the impact of physical injury on PTSD according to the types of trauma. The prevalence of PTSD seems to be higher for specific types of trauma such as sexual violence or

entering war; this suggests that the impact of physical injury on PTSD symptoms might be greater in these traumatic events.

Problem-focused coping did not predict PTSD symptoms at time 1. It also did not impact the rate of change of PTSD symptoms over time. The results imply that the effect of problem-focused coping in overcoming a traumatic situation may be minimal. This view does not correspond with the hypothesis of the traditional stress coping model.<sup>[33]</sup> Thus, we suggest that the effectiveness and the role of problem-focused coping in a traumatic situation need to be reinterpreted.

Recently, Kumari and Mukhopadhyay<sup>[34]</sup> pointed out that “problem-focused actions could be directed at either the environment or the self” (p. 1036). However, in traumatic situations that lead an individual to becoming severely injured, taking control of the environment becomes almost impossible. By contrast, it is possible to reconstruct the traumatic event through changing its meaning. Thus, researchers should explore the impacts of the subfactors of problem-focused actions on PTSD symptoms in future studies.

A particularly important issue in this study is the role of forgiveness as a coping mechanism. The results showed that forgiveness of others (person with fault) was a significant predictor of PTSD symptoms and greater tendency to forgive others was associated with an acceleration of decreasing of PTSD symptoms as time passed. These results support the generalization that forgiveness could be effective in dealing with unintentional traumas (e.g., vehicle accidents) as well as intentional traumas such as interpersonal violence.

Forgiveness encompasses forgiveness of the self and others in specific situations (i.e., state forgiveness) as well as trait forgiveness. Trait forgiveness might be more related to personality, whereas forgiveness of others might be more associated with coping strategies.<sup>[35]</sup> In traditional stress coping theory, forgiveness of others seems to be positively related to problem-focused coping because, like problem-focused coping, it involves the cognitive reframing of a stressful situation.<sup>[21]</sup> Furthermore, exploring the causal relationships between the 2 variables would be meaningful for improving our understanding of the recovery process of patients with PTSD. One of the leading hypotheses is that forgiveness of others might lead to problem-focused coping, which in turn might decrease PTSD symptoms.<sup>[21]</sup>

The limitations of the present study and suggestions for the future studies are as follows. First, in the present study, initial data were collected at 1 to 2 months after a traffic accident, and the second assessment was conducted 6 months later. Variables explaining the development of PTSD, such as coping strategies and forgiveness, could be affected by the time of measurement. Because the measurement period was relatively short, changes in forgiveness and problem-focused coping might not have been evident in some subjects.

Second, it is important to incorporate and comprehend the various variables that affect forgiveness, such as the fault ratio of victims and opponent, whether the perpetrator has apologized,<sup>[36]</sup> and the posttraumatic growth of the victim,<sup>[37]</sup> to expand knowledge of the relationship between forgiveness and PTSD in future studies.

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