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Effect of visible presence of policing activities on drivers' vigilance and intention to refrain from non-driving activities: A scenario-based survey of general Japanese drivers

Yukako Nakano*, Kazuko Okamura, Ritsu Kosuge, Makoto Kihira, Goro Fujita

National Research Institute of Police Science, 6-3-1. Kashiwanoha, Kashiwa-shi, Chiba, 277-0882, Japan

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ABSTRACT

Driver distraction is an important issue for road safety. The visible presence of policing activities alongside roadways seems to be significant in preventing driver distraction and other unsafe driving behaviors. The purpose of this study was to provide evidence of the effectiveness of visible policing presence on drivers' self-reported intention to refrain from non-driving activities and that this effectiveness can be enhanced by manipulating deployment even with limited resources. We conducted a scenario-based survey to compare drivers' self-reported intention to refrain from non-driving activities and their vigilance state across several hypothetical driving situations. The three aims of the study were to examine whether drivers' self-reported vigilance and intention to refrain from non-driving activities were associated with (a) the presence or absence of common forms of roadside policing, (b) the agent (police vs. civilian) and medium (human vs. advertisement) of road safety interventions, and (c) different forms of policing (police officer vs. police car) and their respective levels of conspicuousness.

Japanese drivers ($N = 367$) were randomly assigned to receive one of three booklets that included a scenario-based survey. The three booklets contained different combinations of various hypothetical driving scenarios based on the three experiment designs (a, b, c) described above. Participants were asked to rate their vigilance and their intention to refrain from non-driving activities in hypothetical driving situations that varied by the presence or absence of policing and how conspicuous that presence was. We conducted repeated measures within-subject analysis of variance using the three experimental designs.

The results showed that the presence of a single police unit engaged in policing activities was associated with more vigilance and greater intention to refrain from non-driving activities. The results suggested that effectiveness of visible policing could be enhanced by increasing conspicuousness of police officers in order to help drivers more easily recognize the presence of police without having to purchase extra equipment. These findings provide useful insights for traffic police to conduct routine policing practices more efficiently to address non-driving activities. Future research is needed to examine these results in a real-world setting.

1. Introduction

Driver distraction is the main cause of traffic accidents in Japan. Driver distraction is defined as a diversion of attention away from activities critical for safe driving and toward a competing activity (Regan et al., 2011). The prevalence of non-driving activities should be addressed due to their threat to road safety. These activities impair a range of driving behaviors (e.g., steering performance, speed) as well as visual or internal information searching and processing (e.g., hazard perception) that are critical to safe driving (He et al., 2011; Martens and Brouwer, 2013; Strayer et al., 2015). Hence, Japanese law stipulates that drivers must not be distracted while driving. This means that a wide range of non-driving activities can be illegal if they threaten the traffic safety environment or cause a vehicle accident. However, the National Police Agency of Japan reported that 66% of traffic accidents were related to a driver's failure to pay sufficient attention to safe driving (National Police Agency Bureau of Traffic, 2016). More specifically, 24% of accidents were associated with engagement in non-driving activities. This proportion is much higher compared with accidents related to speeding or drunk driving (both account for less than 1%).

* Corresponding author at: Department of Traffic Science, National Research Institute of Police Science, 6-3-1, Kashiwanoha, Kashiwa-shi, Chiba, 277-0882, Japan.
E-mail addresses: nakano@nrips.go.jp (Y. Nakano), okamura@nrips.go.jp (K. Okamura), kosuge@nrips.go.jp (R. Kosuge), kihira@nrips.go.jp (M. Kihira), fujita@nrips.go.jp (G. Fujita).

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It is difficult to address non-driving activities through law enforcement. Drivers frequently engage in non-driving activities that are difficult for police to detect, such as those that are nonphysical (e.g., thinking to oneself) or intermittent (e.g., manipulating an audio entertainment system). Prat and colleagues (2017) conducted a self-report questionnaire survey of Spanish drivers and found that drivers reported more engagement in less observable non-driving activities such as "looking at something outside the vehicle" (92.1%), "thinking about something unrelated to the driving task" (90.1%), or "manipulating an audio entertainment system" (89.9%) compared to physical activities such as "use of a handheld mobile phone" (32.2%) and "eating and drinking" (51.9%). Although the latter physical activities can be easily seen from outside the vehicle, previous observational studies have reported on the difficulty of detecting those relatively observable non-driving activities (Sullman et al., 2015; Walter et al., 2011). In addition to the extra police resources required for such detection, the diverse nature of non-driving activities complicates the design and implementation of legal sanctions. Hence, most non-driving activities, except for use of electronic devices, are not directly punishable.

As non-driving activities while driving is difficult to observe, it would be helpful to address underlying motivations of engaging in less observable non-driving activities to support enforcement effort. Australian traffic accident data indicated that over 70% of serious road crashes are associated with voluntary non-driving activities (Beanland et al., 2013), such as dialing a mobile phone, texting, manipulating an audio entertainment system, picking up an object, and reading a map. Therefore, one of the effective approach to address less-observable non-driving activities is to remind drivers to refrain from non-driving activities and keep them alert. As drivers self-regulate their engagement in non-driving activities according to the road and traffic environment (Stutts et al., 2005; Tay and Knowles, 2004), it is meaningful to investigate whether driver's intention to refrain from non-driving activities can be increased by roadside interventions such as traffic policing.

1.1. Effect of policing activities presence on drivers' responses

Police presence has long been considered to encourage drivers to behave more safely (Hashimoto, 1979; Rothengatter, 1992; Struckman-Johnson et al., 2015; Tay and Knowles, 2004; Walter et al., 2011). Based on a practical trial of visible police presence in Japan, Hashimoto (1979) suggested that police presence decreased the rate of collisions by making drivers more alert or drive more carefully. More recent studies have investigated drivers reported that they would be less engaged in non-driving activities such as using mobile phone, when police are present (Struckman-Johnson et al., 2015; Tay and Knowles, 2004). Hence, police presence can be expected to make drivers more vigilant and more motivated to refrain from non-driving activities.

Recently, Japanese police have taken an interest in intensifying policing activities to address driver distraction (Honda, 2014; Tanimura, 2015). There are two major forms of policing activities in Japan: routine patrols and stationary police surveillance. Police officers conduct routine vehicle patrols in pairs as part of their duty to prevent crime and accidents (Police Policy Research Center, 2005). In addition, for several decades Japanese police carry out stationary police surveillance with one or two standing police officers to monitor drivers at target intersections (Hashimoto, 1979).

Because of the limited resources, police departments urgently need the knowledge about effective forms of routine policing activities. However, evidence for the effect of these routine policing activities on drivers' intention to refrain from non-driving activities is lacking. Although the effectiveness of a highly visible enforcement campaign which increase the frequency of law enforcement and roadside policing activities to improve driver compliance and reduce road crashes is already known (Walter et al., 2011), the prompt effect of a single police unit engaged in routine policing on road safety is not known. As routine patrol and stationary police surveillance are existing basic police duties, it would be meaningful and cost-effective for traffic police to operate these routine activities more efficiently to enhance drivers' intention to refrain from non-driving activities.

It would be helpful to compare two factors related to policing: the presence of police officers or police cars and its conspicuousness. Results of previous studies have indicated that drivers were less likely to engage in unsafe behaviors when they noticed a stationary police car (Armour, 1986; Kaplan et al., 2000; Tay and Knowles, 2004) or stationary police surveillance by a standing police officer (Hashimoto, 1979). Whereas a stationary police car does not guarantee that police officers are monitoring drivers for unsafe driving behaviors, stationary police surveillance by a standing police officer clearly does. Given that stationary police surveillance seems to exert pressure on drivers to behave safely, we predicted that it would increase drivers' intention to refrain from non-driving activities compared with the presence of a stationary police car. To enhance the conspicuousness of police presence, police-car patrols utilize flashing red lights in Japan (Honda, 2014; Tanimura, 2015). Experimentally, five officers with traffic wands (a red warning light that is usually used for traffic control) in their hands were allocated for stationary police surveillance at traffic accident hot spots (Mimoto, 2014). As these deployment were expected to enhance the impact of police presence as a warning signal, we decided to compare the effect of the conspicuousness of police presence on driver's intention to refrain from non-driving activities.

1.2. The present study

The purpose of this study was to understand the effect of visible policing activities on drivers' intention to refrain from non-driving activities and had three aims.

The first aim was to examine the effectiveness of the most common form of policing on drivers' intention to refrain from non-driving activities.

The second aim was to compare the effect of road safety interventions that are conducted by police with those conducted by other organizations on drivers' intention to refrain from non-driving activities. In addition to the police, safety organizations and civil volunteers also conduct road safety campaigns using media such as roadside advertisements (Rämä and Kulmala, 2000). We were interested in comparing the effectiveness of police interventions with those conducted by other organizations.

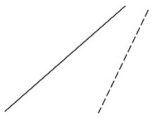
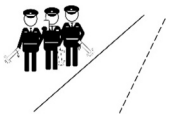
The third aim was to compare different forms and intensities of policing that would require minimum available police resources and those that most Japanese police stations can deploy on a routine basis.

The present study was meant to provide basic knowledge for subsequent experimental trials to be conducted in a real-world setting.

2. Method

We used self-reported intention to refrain from non-driving activities as dependent variables to consider the effect of the presence of policing. Non-driving activities are difficult to observe (Sullman et al., 2015; Walter et al., 2011) so that self-report measures were used. We used intention to refrain from non-driving activities because it taps into underlying motivational factor of non-driving activities. According to the theory of planned behavior (TPB), behavior can be explained by the intention to conduct that behavior (Ajzen, 1991; Elliott et al., 2007). A meta-analysis utilizing 181 TPB studies revealed a strong significant correlation between the intention construct and actual behavior (Armitage and Conner, 2001). Although the present study was not based on TPB, these studies show that driver's intention is a suitable alternative measure to infer the level of engagement in non-driving activities. Furthermore, as police presence may operate as a warning signal to drive safely, drivers would try to sustain their attention to a driving task when they found the presence of policing. Therefore, we measured vigilance in addition to intention.

Table 1a
Experimental Design 1 (Hypothesis 1): Three hypothetical driving situations varied with the presence or absence of visible policing (scenarios are presented in Appendix).

The presence or absence of policing		
Absent	Present	
No intervention (Scenario 1)	*A moving police car with flashing red lights* (Scenario 2)	*Stationary police surveillance by three police officers* (Scenario 3)
		

We conducted a scenario-based survey to explore drivers' psychological responses across several hypothetical driving situations (intention to refrain from non-driving activities and vigilance state). A scenario-based questionnaire is often used to measure drivers' intention or willingness to engage in reckless driving behaviors (McNally and Bradley, 2014a, 2014b). We used this methodology for two reasons. First, it permits manipulation of external environmental factors of a situation. We wanted to compare drivers' responses under several hypothetical driving situations but it would be too expensive to prepare various on-road driving situations and measure drivers' responses in such situations. Second, it would be difficult to obtain cooperation for a social experiment trial in a real-world setting without prior scientific evidence. Therefore, we determined that this methodology would be useful and cost effective to investigate significant external factors associated with drivers' responses.

2.1. Design of scenarios

We constructed three experimental designs (see Tables 1a–1c) to test our research hypotheses (see subsections 2.1.1 to 2.1.3 below). We set out nine hypothetical driving situations that included common forms of policing in Japan, which we discussed with experienced traffic police officers. We determined that a team of three police officers on foot or a single police patrol car (with two officers inside) as a viable and maximum unit of routine policing, which would be considered realistically operational at small sized police stations.

Table 1b
Experimental Design 2 (Hypotheses 2 and 3): Four hypothetical driving situations, including road safety interventions varied with the combination of agent and medium (Scenarios are presented in Appendix).

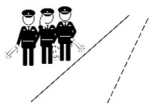
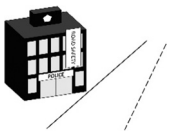
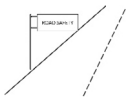
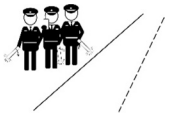
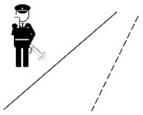
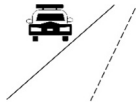
	Agent of Intervention	
	Police	Civilian
Medium of intervention		
Human	*Stationary police surveillance by three police officers* (Scenario 3)	*Road safety campaign by three civil volunteers* (Scenario 5)
		
Advertisement	*A big advertisement board on the police station's wall* (Scenario 4)	*A roadside message board* (Scenario 6)
		

Table 1c
Experimental Design 3 (Hypotheses 4 and 5): Four hypothetical driving situations, including different forms of policing varied with the presence of police officer/police car and their conspicuousness. (Scenarios are presented in Appendix).

	The presence of police officer/police car	
	Police officer	Police car
Conspicuousness		
More conspicuous	*Stationary police surveillance by three police officers* (Scenario 3)	*A parked police car with flashing red lights* (Scenario 8)
		
Less conspicuous	*Stationary police surveillance by a police officer* (Scenario 7)	*A parked police car without flashing red lights* (Scenario 9)
		

2.1.1. Design 1

The first experimental design compared the effects of two common forms of visible policing activities with the same situation without policing (Table 1a). This design included three driving situations: no intervention (scenario 1), a moving police car with flashing red lights (scenario 2), and stationary police surveillance by three officers (scenario 3). Scenarios 2 and 3 were selected because they are the most common forms of policing in Japan. We postulated as follows.

Hypothesis 1. A driving situation with a visible policing presence through basic community policing forms is associated with drivers' greater vigilance state and intention to refrain from non-driving activities when compared with the same situation without a visible policing presence.

2.1.2. Design 2

The second design compared different agents of roadside intervention (police vs. civilian) and media of the intervention (human vs. advertisement) (Table 1b). Both police and civilian organizations conduct roadside interventions using people (e.g., police surveillance and road safety campaigns) and advertisements (e.g., roadside message boards and billboards). Roadside campaigns by civil volunteers (Osaka, 2017) and banners with road safety slogans on police station walls are common (Ishikawa Prefectural Police, n.d.). A comparison between visible roadside policing and road safety interventions conducted by non-police organizations would provide useful information.

We compared four driving situations, including common road safety interventions based on combinations of the agent (police vs. civilian) and medium (human vs. advertisement): stationary police surveillance by three police officers (scenario 3), a big advertisement billboard on a police station wall (scenario 4), a road safety campaign by civil volunteers (scenario 5), and a roadside message board (scenario 6). We postulated as follows.

Hypothesis 2. A driving situation in the presence of road safety intervention delivered by police is associated with drivers' greater vigilance state and intention to refrain from non-driving activities when compared with the same situation in the presence of the intervention delivered by civilians.

Hypothesis 3. A driving situation in the presence of manned road safety intervention is associated with drivers' greater vigilance state

and intention to refrain from non-driving activities when compared with the same situation in the presence of unmanned intervention.

2.1.3. Design 3

The third design compared the presence of a police officer/police car and the conspicuousness of that presence. We manipulated conspicuousness by changing the number of police officers and through the presence or absence of flashing red lights of a police car (Table 1c). Based on the combination of these two variables, four recognizable forms of roadside policing equipment were used: stationary police surveillance by three police officers (scenario 3), stationary police surveillance by a police officer (scenario 7), "a parked police car with flashing red lights" (scenario 8), and "a parked police car without flashing red lights" (scenario 9). We postulated as follows.

Hypothesis 4. A driving situation in the presence of stationary police surveillance by a lone police officer is associated with drivers' greater vigilance state and intention to refrain from non-driving activities when compared with the same situation in the presence of a police car, regardless of the number of police officers inside.

Hypothesis 5. A driving situation in the presence of more conspicuous forms of policing activities is associated with drivers' greater vigilance state and intention to refrain from non-driving activities when compared with the same situation in the presence of less conspicuous forms of policing activities.

2.2. Participants

Participants were recruited at a Driving License Center located in Ibaraki Prefecture in Japan (100 km northeast of Tokyo). The number of automobiles per resident in Ibaraki is above the average in Japan (Ibaraki Prefectural Government, 2016). Participants were recruited by either direct contact from the research team (response rate: 64.7%) or through an advertisement distributed at the Driving License Center. Participants were randomly assigned to one of three experimental designs (Tables 1a–1c).

2.3. Procedure and materials

We first ensured that all participants understood the purpose of the study. The participants then received a survey booklet. They completed the booklet anonymously at their own pace (about 10–20 min). We conducted a preliminary survey of several drivers and confirmed that they correctly comprehended the instructions, questionnaires and the scenario descriptions. To avoid any misunderstanding of the instructions and questionnaire and variability in participants' interpretation of the scenario descriptions, the research team waited nearby to assist the participants whenever they had difficulty understanding the scenarios or answering the questionnaire. In exchange for their completed booklet, each participant received a financial reward of 500 Japanese yen.

The booklet was divided into two parts. The first part included demographic measures such as sex, age, purpose of visiting the Driving License Center, driving experience, and main reasons for driving. The second part consisted of a scenario-based survey. Participants were instructed to read scenarios depicting various driving situations and to rate their vigilance and intention to refrain from non-driving activities. There were three booklets, each corresponding to one of the three experimental designs (Tables 1a–1c). To avoid over-burdening the participants, each participant randomly received one of the three booklets. Each booklet contained a combination of three or four scenarios related to the experimental design. We also prepared several versions of the scenario combinations by randomizing the presentation order of the scenarios to lessen the order effect.

2.3.1. Description of scenarios

Several hypothetical driving situations described the basic driving scenario and road safety intervention scenarios. We used only a written description to avoid any unexpected influence of specific external factors included in the driving scene.

A basic driving scenario was utilized to control participants' basic idea of the driving environment. Thus, the basic driving scenario was presented to all participants first, followed by different road safety intervention scenarios. All scenarios were written in the second person singular. We used simple and unambiguous language to show the essential details of the scenarios. Details of full scenarios can be found in the Appendix.

2.3.1.1. Basic driving situation. A general driving situation thought to encompass driver inattention was devised as the basic driving situation in this study. Berthié et al. (2015) showed that drivers tend to be inattentive when they are tired and driving a familiar route. Therefore, we depicted a driving situation in which the driver takes their usual route home from work on a weekday.

2.3.1.2. Road safety intervention scenarios (Scenarios 1–9). We devised nine scenarios based on three designs (Tables 1a–1c). Excluding scenario 1, the remaining eight scenarios described commonly seen road safety interventions. Six out of eight interventions were conducted by police: a moving police car (with flashing red lights), stationary police surveillance (with either one or three police officers), a parked police car (with/without flashing red lights), and a big advertisement board on a police station wall. The other two interventions were conducted by non-police organizations: a road safety campaign (with three civil volunteers) and an electric message board.

2.3.2. Measures

Self-reported measures of drivers' vigilance state and intention to refrain from non-driving activities were used. Self-reported vigilance state was assessed by the item "[scenario description] … In this situation, do you feel alert?" scored as (1) *strongly disagree* to (6) *strongly agree*. Self-reported intention to refrain from non-driving activities was assessed by six items "[scenario description] … In this situation, to what extent do you try to refrain from (manually using a mobile phone such as texting / reaching for an object / looking at a navigation system or electronic device / watching TV or a movie / thinking about things unrelated to driving such as upcoming schedule / internalized thoughts)." These six non-driving activities were selected from previous studies of driver inattention (Sullman et al., 2015; Tay and Knowles, 2004). The first two behaviors involve physical but intermittent activities that would be easy for drivers to conceal deliberately. The second two behaviors were visual activities and the last two were cognitive activities, which are difficult to observe. We calculated Cronbach's α coefficients for the six items. As reliability was high for each situation ($\alpha > .92$), we used the average scores in subsequent data analysis.

3. Data analysis

We conducted repeated measures (within-subject) analysis of variance (ANOVA) using three experimental designs. ANOVAs were conducted to compare vigilance and drivers' intention to refrain from non-driving activities as depicted in the scenarios. All analyses were performed using the package Anovakun software v.4.8.0 (Iseki, 2016) under R 3.2.4 (R Development Core Team, 2016).

Because Mendoza's multisample sphericity test was significant, the degrees of freedom were adjusted using the Greenhouse-Geisser epsilon method to avoid type I errors. We used the Holm procedure for the post hoc multiple comparisons (Field et al., 2012).

Two measures of effect size were calculated for all ANOVAs. Although the partial eta squared is the most widespread measure of effect size with ANOVA, it cannot be used to compare effects using a

within-subject design and between-subject variables (Olejnik and Algina, 2003). Thus, we also calculated generalized eta squared (η^2_G). This measure is intended to solve the problem of the partial eta squared in comparing across designs. The common guideline for η^2 suggested by Cohen can be applied to η^2_G (Bakeman, 2005).

4. Results

4.1. Demographics

Responses from ten participants were excluded due to missing data leaving a total of 367 drivers (244 men, 123 women) whose answers were used in the analyses. Booklet 1 was completed by 125 participants, booklet 2 by 122 participants, and booklet 3 by 120 participants.

All participants had a valid driver's license and reported that they had driven at least once over the preceding three months. Participants ranged in age from 20 to 72 (*Mean* [*M*] = 41.49, standard deviation [*SD*] = 12.41) years and had between 2 and 50 (*M* = 22.82. *SD* = 12.21) years of experience as a qualified driver. Most of the respondents drove regularly (79.8% "almost every day," 17.8% "more than once per week"). Annual mileage ranged from 20 to 163,800 km (*M* = 16,747.90, *SD* = 23,265.61). More than 60% answered that the most frequent reason for driving was to travel to and from work and/or school (64.3%); 6.8% were professional drivers. During the preceding three years, 139 participants had been ticketed and 95 had been involved in a traffic accident.

We compared differences in participants' age, annual mileage, years of experience as a qualified driver, and driving frequency between the three booklet types using one-way repeated measures ANOVA and compared involvement in traffic accidents and receiving traffic tickets using the chi-square test. A significant difference was found for driving frequency (F [2,366] = 3.716, p = .03, η^2 = 0.02, η^2_G = 0.02). Average driving frequency of the booklet 1 group (*M* = 5.81, *SD* = 0.73) was higher than that of the booklet 3 group (*M* = 5.50, *SD* = 1.19), but no significant difference was found with the booklet 2 group (*M* = 5.58, *SD* = 0.86). In addition, receiving traffic tickets was significantly different (χ^2 = 6.796, p = .03). The booklet 2 group included more drivers who had not received a traffic ticket (n = 87). There was no significant difference in the other groups (participants who had not received a traffic ticket: booklet 1 n = 70; booklet 3 n = 70).

4.2. Effect of presence of visible policing activities (analysis 1)

One-way repeated measures ANOVAs were conducted to compare vigilance and intention to refrain from non-driving activities across the three situations: no intervention (scenario 1), a moving police car with flashing red lights (scenario 2), and stationary police surveillance by three police officers (scenario 3) (see Table 2).

ANOVA results revealed significant differences across the three situations for both vigilance (F [1.52, 124] = 76.14, p < .01, η_p^2 = .38, η_G^2 = .18) and intention to refrain from non-driving activities (F [1.49, 124] = 47.58, p < .01, η_p^2 = .28, η_G^2 = .08).

Table 2
Means (standard deviations) of self-reported vigilance and intention to refrain from non-driving activities by three scenarios of visible policing presence.

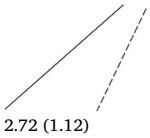
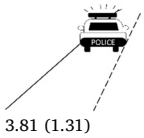
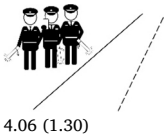
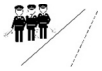
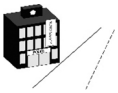
	No intervention (Scenario 1)	*A moving police car with flashing red lights* (Scenario 2)	*Stationary police surveillance by three police officers* (Scenario 3)
			
Vigilance	2.72 (1.12)	3.81 (1.31)	4.06 (1.30)
Intention	4.29 (1.21)	4.93 (1.14)	5.05 (1.11)

Table 3
Mean scores (standard deviations) of vigilance and intention to refrain from non-driving activities by four scenarios of road safety interventions varied with their agent (police vs. civilian) and medium (human vs. advertisement).

Agent	Police		Civilian	
Medium	Human	Advertisement	Human	Advertisement
	Stationary police surveillance by three police officers (Scenario 3)	*A big advertisement board on the police station's wall* (Scenario 4)	*Road safety campaign by three civil volunteers* (Scenario 5)	*Roadside message board* (Scenario 6)
				
Vigilance	4.23 (1.21)	3.30 (1.19)	3.10 (1.14)	3.27 (1.23)
Intention	4.78 (1.34)	4.38 (1.37)	4.15 (1.47)	4.32 (1.39)

Post hoc analyses were conducted for both measures, and all pairwise comparisons detected statistically significant differences. Means for vigilance and intention to refrain from non-driving activities were higher in the scenario 2 and the scenario 3, compared with the scenario 1 (*p*s < .01). Moreover, means for vigilance and intention to refrain from non-driving activities were higher in the scenario 3 than the scenario 2 (p < .01 for vigilance; p = .03 for intention to refrain from non-driving activities).

4.3. Effect of agent and medium of the road safety intervention (analysis 2)

We conducted a 2 (agent of intervention: police vs. civilian) × 2 (medium of intervention: human vs. advertisement) within-subject ANOVA for vigilance state and intention to refrain from non-driving activities (see Table 3).

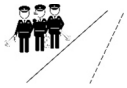
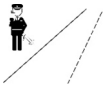
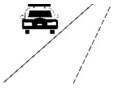
Results showed significant main effects of agent on vigilance (F [1, 121] = 62.07, p < .01, η_p^2 = .34, η_G^2 = .06) and intention to refrain from non-driving activities (F [1, 121] = 35.15, p < .01, η_p^2 = .23, η_G^2 = .02). Main effects of medium on vigilance (F [1, 121] = 25.63, p < .01, η_p^2 = .18, η_G^2 = .03) and intention to refrain from non-driving activities (F [1, 121] = 4.68, p = .03, η_p^2 = .04, η_G^2 < .01) were significant. Moreover, interactions between agent and medium on vigilance (F [1, 121] = 60.01, p < .01, η_p^2 = .33, η_G^2 = .05) and intention (F [1, 121] = 17.53, p < .01, η_p^2 = .13, η_G^2 = .01) were significant.

Post hoc analyses showed significant single main effects of agent, only for the human interventions, on vigilance (F [1,121] = 111.43, p < .01, η_p^2 = .48, η_G^2 = .19) and intention to refrain from non-driving activities (F [1,121] = 46.76, p < .01, η_p^2 = .28, η_G^2 = .05). Mean scores for vigilance and intention to refrain from non-driving activities were higher in the scenario 3 than in the scenario 5, whereas there were no significant differences between the scenario 4 and the scenario 6. In addition, there were significant main effects of medium only for the intervention by police on vigilance (F [1,121] = 75.31, p < .01, η_p^2 = .38, η_G^2 = .13) and intention to refrain from non-driving activities (F [1,121] = 26.06, p < .01, η_p^2 = .18, η_G^2 = .02). Mean scores for vigilance and intention to refrain from non-driving activities were higher in the scenario 3 than the scenario 4, whereas there were no significant differences between the scenario 5 and the scenario 6.

4.4. Effects of policing forms: presence of police officer/police car and conspicuousness of policing (Analysis 3)

We conducted 2 (police officer vs. police car) × 2 (more vs. less conspicuousness) ANOVAs for vigilance and intention to refrain from non-driving activities (see Table 4).

Table 4
Means (standard deviations) of vigilance and intention to refrain from non-driving activities by four scenarios of visible policing forms varied with the presence of police officer/police car and their conspicuousness.

	Presence of police officer		Presence of police car	
	More conspicuous	Less conspicuous	More conspicuous	Less conspicuous
	Stationary police surveillance by three officers (Scenario 3)	*Stationary police surveillance by one officer* (Scenario 7)	*A parked police car with flashing red lights* (Scenario 8)	*A parked police car without flashing red lights* (Scenario 9)
				
Vigilance	3.75 (1.29)	3.55 (1.33)	3.55 (1.31)	3.38 (1.30)
Intention	4.38 (1.44)	4.27 (1.45)	4.20 (1.41)	4.11 (1.41)

The results revealed significant main effects of presence of police officer/police car on vigilance (F [1, 119] = 13.38, $p < .01$ $\eta_p^2 = .10$, $\eta_G^2 = .01$) and intention to refrain from non-driving activities (F [1, 119] = 17.10, $p < .01$, $\eta_p^2 = .13$, $\eta_G^2 < .01$). Mean scores for vigilance and intention to refrain from non-driving activities while driving were higher when a police officer was present (regardless of the number of officers; the scenario 3 and the scenario 7) than when a police car was present (regardless of the presence or absence of flashing red lights; the scenario 5 and the scenario 6).

Furthermore, main effects of conspicuousness on drivers' vigilance state (F [1, 119] = 17.60, $p < .01$, $\eta_p^2 = .13$, $\eta_G^2 = .01$) and intention to refrain from non-driving activities (F [1, 119] = 7.67, $p < .01$, $\eta_p^2 = .06$, $\eta_G^2 < .01$) were significant. More specifically, the more conspicuous policing condition (the scenario 3 and the scenario 8) was associated with more scores on both measures compared with the less conspicuous policing condition (the scenario 7 and the scenario 9). No significant interaction effects were found.

5. Discussion

5.1. Summary and interpretation

This study aimed to explore effects of different forms of visible policing activities on driver's self-reported vigilance and intention to refrain from non-driving activities. We also aimed to investigate the effect of conspicuous policing activities to suggest viable and efficient operation of routine policing. Ultimately, the goal of the present study was to better understand how police can maximize the effects of routine traffic policing by utilizing existing stationary police surveillance or patrol operations (i.e., increasing conspicuousness of current policing practices), and thereby contribute to deterring unsafe road user behavior, including less observable non-driving activities.

We constructed five hypotheses. Hypothesis 1 postulated that the presence of basic forms of policing activities would be associated with drivers' greater self-reported vigilance state and intention to refrain from non-driving activities when compared with the same situation when police were absent. As shown in the results of analysis 1, participants reported that they were more likely to refrain from non-driving activities when they found the police engaged in basic policing activities (stationary police surveillance by three police officers and a moving police car with flashing red lights). This result supported Hypothesis 1. As suggested in the results of analysis 2, agent of road safety intervention (police vs. civilian) was associated with drivers' self-reported vigilance state and intention to refrain from non-driving activities when the medium of intervention was human. These results demonstrated that drivers' responses were higher in the police surveillance scenario with three police officers than in the road safety campaign by three civilian volunteers. Additionally, their responses were higher in the police surveillance scenario with three police officers than in the advertisement billboard at a police station. These results partially supported Hypotheses 2 and 3. The results of analysis 3 demonstrated that drivers' self-reported vigilance state and intention to refrain from non-driving activities were higher in the scenario of police surveillance by police officers compared with that of a parked police car. These results supported Hypothesis 4. In addition, the results of analysis 3 indicated that more conspicuous forms of policing activities were associated with drivers' greater self-reported vigilance state and intention to refrain from non-driving activities. These results supported Hypothesis 5.

The findings in support of Hypotheses 1 were consistent with previous studies on the evaluation of roadside policing activities that suggested the presence of police decreases drivers' intention to participate in non-driving activities (Struckman-Johnson et al., 2015; Tay and Knowles, 2004). We interpreted this finding to mean that the presence of policing activities (by three police officers, a moving police car with flashing red lights) raises driver's perceived risk of apprehension. This interpretation has been widely accepted in previous studies about the effect of speed enforcement (e..g, Tay, 2005; Walter et al., 2011). Although many non-driving activities is not explicitly illegal, the probability of violations such as a failure to notice a change in the traffic signal and exceeding speed limits, increases when drivers engage in non-driving activities (He et al., 2011; Martens and Brouwer, 2013; Young et al., 2013). Moreover, previous studies revealed that a substantial portion of drivers thought that non-driving activities are illegal (Prat et al., 2017). Therefore, the impression of a higher probability of apprehension may mediate the link between the presence of policing activities and the driver's intention to refrain from non-driving activities.

Contrary to our prediction, there were no differences in self-reported vigilance and intention to refrain from non-driving activities between the agents of advertisement (police vs. civilian) and the medium of civilian road safety interventions (human vs. advertisement). The results indicated that the presence of policing activities raises driver's greater self-reported vigilance and intention to refrain from non-driving activities compared with other road safety interventions shown in the present study. These findings also suggested difference of the effectiveness between punitive interventions (e.g., withdrawal of points from their license) and non-punitive interventions. The presence of policing activities which may evoke the penalty as a negative consequences of unsafe driving behaviors would be perceived as more powerful intervention (Auzoult et al., 2015). In this regard, the mere sight of a police station as well as other civilian interventions presented in design 2 may not have given enough impact.

This interpretation is consistent with the result that the effect sizes of the agent of human interventions and the medium of police interventions were much larger for self-reported vigilance than for intention to refrain from non-driving activities. The presence of punitive interventions may operate efficiently as a warning signal to increase driver's alertness, because the penalty is perceived as a personal threat. Hence, vigilance is assumed to be more susceptible to the effectiveness of punitive interventions than their intention to refrain from non-driving activities. However, driver's self-assessment of vigilance may lack credibility (Schmidt et al., 2009), so that future studies are needed to investigate the impact of policing activities on driver's vigilance using objective measures.

Findings in support of Hypothesis 4 suggested that drivers were more likely to refrain from non-driving activities when they noticed

police officers on the roadside than when they saw a police car. Previous studies suggested that the number of unsafe driving behaviors were reduced by the presence of a stationary police car (Armour, 1986; Kaplan et al., 2000) and by the presence of stationary surveillance by police officers (Hashimoto, 1979). To our knowledge, the present study is the first to compare the effect of these two common forms of policing. We interpreted that the visible presence of standing police officers had a greater impact than a police car (without visible police officers) because it may exert more pressure on drivers by means of surveillance. Findings from Hypothesis 5 suggested that increased conspicuousness will enhance the effect of the policing activities on drivers' vigilance and intention to refrain from non-driving activities. Our possible interpretation is that the effectiveness of policing activities is mediated by driver's perceived probability of apprehension. The number of police officers will raise drive's perceived probability of apprehension. The flashing red lights of the police car implies the presence of police officers nearby.

Because the Japanese police must confront the issue of driver inattention and distraction, these results provide fruitful suggestions for them. The present study manipulated the presence of police officers and level of conspicuousness within the range of available police resources, and indicated that such equipment may enhance driver's intention to refrain from non-driving activities. Car patrols and stationary surveillance by a standing police officer is a major duty of the Japanese police (Police Policy Research Center, 2005), and they have been using flashing red lights on car patrols to help drivers more easily notice the police (Honda, 2014; Tanimura, 2015). Therefore, these findings provide a guide to increase the effectiveness of ongoing viable forms of policing activities to address driver distraction.

5.2. Limitations and suggestion for future research

This study has some limitations. First, we assumed that non-driving activities are controllable but drivers can nonetheless be engaged in non-driving activities involuntarily such as receiving phone calls or messages. Some problematic non-driving activities may qualify as addictive activities (De-Sola Gutiérrez et al., 2016), however, this study was limited to more voluntary activities. Second, we asked participants to report their intention and vigilance, but drivers may have difficulty in accurately reporting certain non-driving activities (e.g., inner thoughts) or their vigilance state (Horrey et al., 2008; Kaye et al., 2018). Moreover, self-report measures are susceptible to social desirability. Therefore, self-reported intentions may not always predict actual behavior. Third, the results of this study depended on participants' responses for the literal description of the scenarios. Our scenarios ensured that drivers detected roadside interventions, but it is always possible that drivers may fail to recognize their presence in real-world settings. Because of these limitations, the findings of this study should be carefully translated into the real-world situations. Future studies should examine the effectiveness of visible presence of policing activities on drivers' behaviors in a real-world setting. The preliminary result of a pilot trial conducted in a natural setting suggested that the rate of observed violations at the surveillance site decreased when a police unit was present (Okamura et al., 2018). Because it is suggested that the effectiveness of the presence of police on deterring unsafe driving behaviors is a temporary solution (Armour, 1986), it would be insightful to measure any lasting effect of the presence of policing activities in real-world.

Fourth, the effect of police presence on drivers' intention to refrain from non-driving activities could be mediated by drivers' perceived risk of apprehension in each scenario. Some drivers, in particular risk takers, may disobey the law when perceived level of enforcement is low (Tay and De Barros, 2011). There is some argument that a visible police presence alongside the road is insufficient to convey the correct impression of high enforcement level (Ryeng, 2012). Future research that focuses on psychological factors such as driver's knowledge of enforcement and perceived risk of apprehension, is needed to address underlying mechanisms of drivers' perception under each scenario.

At last, demographic variability between different booklet groups may have affected the results. Participant groups differed according to driving frequency (higher frequency in the booklet 1 group) and experience in citation (fewer participants had received a traffic ticket in the booklet 2 group). Drivers' perception for enforcement or penalty is associated with their familiarity with the road environment and citation experience (Ryeng, 2012). These demographic variabilities that might affect drivers' responses to the presence of police should be considered in the future studies.

6. Conclusion

To enhance understanding of the effectiveness of the visible presence of policing activities to address driver distraction, we investigated drivers' self-reported intention to refrain from non-driving activities and vigilance in scenarios of a hypothetical driving situation that varied by presence of policing.

We examined whether drivers' self-reported vigilance state and intention to refrain from non-driving activities were associated with (a) the presence or absence of common forms of roadside policing activities, (b) the agent (police vs. civilian) and medium (human vs. advertisement) of road safety interventions, and (c) different forms of policing activities (police officer vs. police car) and level of conspicuousness.

The results showed that greater vigilance and intention to refrain from non-driving activities were associated with the visible presence of a single police unit engaged in common forms of routine policing activities in Japan. The results also indicated that drivers were more likely to intend to refrain from non-driving activities when they noticed the actual presence of police officers who were engaged in police stationary surveillance when compared with other road safety interventions conducted by non-police organization. These findings supported the effectiveness of routine policing activities in Japan on increasing driver's intention to refrain from non-driving activities. In addition, these findings suggested that the effectiveness of policing activities could be enhanced by manipulating deployment with limited police resources. Although routine policing activities by fewer than four police officers and a police car would be a relatively small-scale intervention, to maximize their effect with available resources is important to achieve road safety. Future studies are needed to investigate further details of drivers' perception such as risk perception of the presence of policing activities, and to examine the effectiveness of such basic traffic policing activities in a real-world setting.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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The views and opinions expressed in this article are purely those of the authors and do not reflect the official views of the National Police Agency.

Appendix A

Description of scenarios and combinations of the scenarios used in each booklet

(Basic driving situation scenario)

It is about 17:00 on a weekday. You are driving home alone. The road is an arterial two-lane road that you travel frequently. You are in medium-density traffic. You are familiar with this route and have never been involved in a traffic accident along this road.

(Road Safety intervention scenarios)

Scenario 1 - No intervention

Scenario 2-A moving police carwith a flashing red light

You noticed a marked police car ahead of you while driving in the basic driving situation [Scenario 1]. The police car was driving with flashing red lights, but no police siren blaring.

Scenario 3-Stationary police surveillance by three police officers

You noticed three police officers standing by the roadside while driving in the basic driving situation [Scenario1]. They were watching cars driving down the road while holding traffic wands (red warning lights that are usually used for traffic control) and walkie-talkies in their hands.

Scenario 4 - A big advertisement board on the police station's wall

You noticed a police station while driving in the basic driving situation [Scenario 1]. You could see a big advertisement board at the station with the statement "Traffic accidents are on the rise in this area."

Scenario 5 - Road safety campaign by three civil volunteers

You noticed three civil volunteers by the roadside while driving in the basic driving situation [Scenario1]. They were wearing fluorescent jackets and holding flags with the statement "Road safety campaign underway."

Scenario 6 - A road safety message on a roadside message board

You noticed an electric board by the roadside while driving in the basic driving situation [Scenario1]. You could see the board with a flashing road safety message stating "Traffic accidents are on the rise in this area."

Scenario 7 - Police surveillance by a police officer

You noticed a police officer standing by a traffic light while driving in the basic driving situation [Scenario 1]. The officer was watching cars driving down the road while holding a traffic wand (a red warning light that is usually used for traffic control).

Scenario 8 - A parked police car with a flashing red light

You noticed a marked police car by the roadside while driving in the basic driving situation [Scenario 1]. The police car was stopped with flashing red lights but without a police siren blaring. You could not see inside the car well enough to ascertain the presence of a police officer.

Scenario 9 - A parked police car without flashing red lights

You noticed a marked police car by the roadside while driving in the basic driving situation [Scenario 1]. The police car was stopped without flashing red lights or blaring police siren. You could not see inside of the car well enough to ascertain the presence of a police officer.

Note. The *No Intervention* scenario does not contain information in addition to the basic scenario.

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