Driver’s vehicle horn use and its effects on other drivers and pedestrians: A case study in South Korea

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Abstract
In previous studies, questionnaire surveys were used to investigate the current circumstances of vehicle horn use and its effects on drivers and pedestrians in Japan. Several cities in other countries face more serious noise problems related to the use of car and motorbike horns. In urban areas of South Korea, frequent vehicle horn use on roads was found through onsite inspections. Measurements of noise at crossroads with heavy traffic revealed frequent horn use with high sound pressure level. In such areas, it is necessary to clarify the current circumstances of vehicle horn use, including its effects. Therefore, a survey on such use, similar to the previous work, was carried out. The survey included questions on the latest or last-remembered case of horn use in various situations in which the respondent was a driver or pedestrian. It was found that many pedestrians had experiences of being honked at by a single honk, two short honks and a long honk. Such honking mostly aroused negative psychological reactions such as feeling startled, a sensation of noisiness and feeling irritated. There were no significant relationships between questionnaire items regarding the driver’s own horn use, suggesting there is no particular manner of such use. Relationships between driver awareness of their own horn use and its mode suggested that drivers who did not usually honk had feelings of reluctance to use the horn, and that they briefly honked out of necessity.

Key words: Vehicle horn, Intent, Timing pattern, Driver, Pedestrian, Driver awareness, Psychological reaction

1. Introduction

The horn was originally installed in vehicles for warning others of danger and avoiding dangerous situations during driving. In Japan, drivers use their vehicle horn as a signal in various situations such as when passing each other, although the Japanese Road Traffic Law states that the horn should be used only in an emergency or in dangerous locations (National Police Agency of Japan, 2015). The actual horn use may create a noise issue in neighborhoods. Furthermore, drivers often honk at pedestrians and cyclists who are unaware of the driver’s car approaching from behind. The A-weighted sound pressure level of a vehicle horn as measured in front of the vehicle is very high (93–112 dB) (Ministry of Land, Infrastructure, Transport and Tourism, 2003), and potential adverse effects of horn use on people outside the vehicle, such as pedestrians and cyclists, has therefore been a concern. To investigate the issue of vehicle horn use described above, questionnaire surveys were used in previous studies in Japan (Takada et al., 2013, 2014). The questionnaire results revealed that vehicle horns were frequently used by drivers to communicate with other drivers (e.g., for expressing gratitude or gaining another’s attention). The previous surveys also reported negative
psychological impacts of vehicle horn use, not only on drivers but also pedestrians.

Situations in several cities outside Japan are more serious. Many face noise problems related to the use of car and motorbike horns (Onuu, 2000; Ali and Tamura, 2002; Phan et al., 2010; Roy et al., 2012). In considering countermeasures for the adverse effects of horn use in such areas, it is necessary to investigate the current state of such use. It is assumed that a questionnaire survey similar to that used in earlier studies in Japan (Takada et al., 2013, 2014) would be able to clarify that state in areas facing the noise problem.

For noise problems of vehicle horn use, design of the car horn sound is an effective countermeasure against adverse effects. In other studies that have proposed methods to synthesize car horn sounds for recognition as genuine, quality assessments were made for existing horn sounds, and acoustic properties that are important to listener recognition of car horn sound were investigated (Lemaitre et al., 2007, 2009). The design of a dual-shell car horn with good sound quality in the car compartment was also developed based on the sound quality assessment and physical optimization using numerical methods (Kang et al., 2015). These research works mainly addressed the sound quality of vehicle horns, and did not address their effects on people outside the vehicle. For hearing horn sounds both inside and outside the vehicle, our previous psychoacoustic studies investigated effects of the acoustic properties of horn sound on auditory impressions and interpretations of the reasons for horn use by drivers (Takada et al., 2010; Takayama et al., 2012). These were done to address how negative reactions to horns can be reduced, and revealed that negative impressions of vehicle horns could be ameliorated by modifying the acoustic properties of horn sound, such as their temporal and spectral features.

The international regulation standard regarding audible warning devices of motor vehicles, which links with similar standards and laws in various countries including Japan, states that the A-weighted sound pressure level of a horn should be not less than 93 dB and not more than 112 dB, measured at a distance of 7 m in front of a vehicle (UN Vehicle Regulations, 1972, 1984). In view of recent reductions of road traffic noise in various countries, a proposal for reduction of the lower limit of the A-weighted sound pressure level (from 93 to 87 dB) in the current standard was submitted and agreed upon in the Working Party on Noise of the World Forum for Harmonization of Vehicle Regulations (Economic and Social Council of United Nations, 2014). In the near future, this proposal will be reflected by similar standards concerning horn sound in various countries. However, the noise problem of horn use may still exist, because the higher limit of A-weighted sound pressure level (112 dB) remains the same.

Any change to the sound of vehicle horns may not completely solve the noise problem related to their use as long as the current horn system, in which sounds with high sound pressure level are emitted outside of vehicles, continues to exist in society. To fundamentally solve the problem of vehicle horn use, it may be necessary to alter human traffic behavior, e.g., unnecessary horn use. In traffic psychological research, horn use has been regarded as a behavior reflecting driver aggression (Doob and Gross, 1968). In the present study, therefore, we also considered driver horn use as a type of traffic behavior, and investigated traffic psychological factors affecting that use.

The purpose of the present research was to find various countermeasures to reduce the adverse impacts of vehicle horn use on humans or environment in areas facing noise problems caused by that use. To achieve our objective, relationships between the manner of driver horn use and various factors such as traffic conditions and driver intent, and effects of horn use on listeners’ psychological reactions should be clarified. We therefore carried out questionnaire surveys to investigate the above-mentioned relationships concerning vehicle horn use in urban areas of South Korea, where frequent horn use on roads was found through onsite inspection. First, in a preliminary survey, road traffic noise was measured at crossroads with heavy traffic to grasp the current state of horn use. Noise measurements indicated frequent use at these sites. We thus used the questionnaire survey on vehicle horn use similar to that previously used, to which questions from the perspective of traffic psychology were added.

2. Noise measurements

2.1 Procedure

As a preliminary survey to grasp the current state of vehicle horn use, noise measurements were conducted at crossroads with heavy traffic in Seoul, South Korea. For reasons such as safety, convenience of noise measurement and police permission, two crossroads near subway stations (Gangnam-gu office station and Seonjeongneung station at Gangnam-gu, Seoul), where roads with three or four lanes in each direction cross, were chosen for noise measurement. Measurements were made over 2.5 days in November 2013 at the crossroad near Gangnam-gu office station, and 5
days in October 2014 at the crossroad near Seonjeongneung station. Noise level was continuously measured for 11 hours (8:00–19:00), although measurement on a weekend in November 2013 was done only for 6 hours (13:00–19:00 on Sunday) because of the adverse weather. Data of noise level and road traffic noise including horn sounds were recorded using a sound-level meter (RION NL-52). A microphone was located 1.5 m above the ground at the road edge. Times of vehicle horn use were also recorded during the noise measurement.

2.2 Results

Frequency and noise level values of horn sounds were obtained using data management software (RION AS-60RT), in which noise levels are indicated by comparing with recorded horn sounds correspondent in time.

Figure 1 shows the frequency of vehicle horn use in each time interval on each day. Median frequencies on each day aside from one weekday were between 49 and 93. The frequency on one weekday (Tuesday) in November 2013 was higher than those on the other days. There were on average more than 100 horn uses per hour on that day (the median frequency was 131). In South Korea, drivers are permitted to turn right at a crossroad even if the traffic light controlling traffic flow straight ahead is red. There were thus frequent cases in which a driver wanting to turn right at the crossroad had to wait behind another driver waiting for the light to turn green, so the former honked to request the latter to get out of the way. Such traffic regulation appears to be one reason that horns were frequently used at the surveyed crossroads. The noise level of horn sounds in each time interval on each day varied. Most mean noise levels measured at the sites were around 71 to 75 dB, although there were some levels > 75 dB, and values were widely distributed according to distances between vehicles and the sound-level meter.

Korean standards concerning vehicle horn sound (Ministry of Environment, 2015) are approximately equivalent to the international standards mentioned above (UN Vehicle Regulations, 1972, 1984). The A-weighted sound pressure level of horn sound thus reaches ~100 dB in proximity to the vehicle. In urban areas, therefore, people outside the vehicle such as pedestrians and cyclists may be exposed to frequent horn sounds with high sound pressure level. In fact, the present measurements indicate that people near crossroads were often exposed to horn sounds with noise levels > 70 dB. The previous psychoacoustic study investigating the effects of horn sounds on auditory impressions in both the driving and pedestrian conditions suggested its negative effects, particularly on pedestrians (Takada et al., 2010).

3. Questionnaire survey on vehicle horn use

3.1 Outline of survey

It should be difficult to perform on-the-spot investigations of drivers’ or pedestrians’ reactions because horn use does not steadily occur, and it is impossible to forecast the occurrence of horn use. Therefore, to clarify the detailed state of vehicle horn use including effects of that use on people, the questionnaire survey on horn use was executed.

A questionnaire form similar to that used in our previous studies (Takada et al., 2013, 2014) was used. The main questions related to the use of vehicle horns. Respondents were asked about the latest or last-remembered case of (I) their own horn use and (II) their experiences of being honked at by another driver in various situations when driving.
They were also asked about (III) their experiences of being honked at by a driver while a pedestrian. With regard to (I) and (II), the questionnaire sought details such as time, place, traffic volume, intent of horn use, and timing pattern of honking. Moreover, respondents were asked about the target of their horn use and their psychological reactions when honked at by another driver. With regard to (III), respondents were asked about the driver’s reason for using the horn, timing pattern of honking, and their psychological reaction to it. The main parts of the questions were represented in Appendix.

The questionnaire also included questions similar to those in a form proposed by the Acoustical Society of Japan for a social survey of noise problems (Namba et al., 2010), such as a query concerning sounds that the respondent hears in daily life at home and their responses (e.g., whether they found a sound to be annoying), and their personal attributes (e.g., age, gender and occupation). Regarding sounds heard at home, the questionnaire included questions on the nature of the annoyance felt by respondents in response to hearing a vehicle horn, the time when they heard the horn, and their coping behaviors. For almost all questions, respondents selected one among multiple choices (see Appendix).

Vehicle horn use appears to be affected by various factors such as traffic conditions, the object, and driver intention. Our previous survey in Japan revealed relationships between circumstances surrounding drivers who used their horn and the type of honking (Takada et al., 2013, 2014). These factors are considered to be extrinsic factors of driver horn use. The intrinsic factors of drivers, such as attitude, personal norms (i.e., social motive or another person’s appreciation) and moral obligation (i.e., ethical viewpoints), also may affect a driver’s horn use. According to a traffic behavior model (Fujii, 2002) (see Fig. 2), factors including personal attitude (defined as preference), personal norms, perceived behavioral control (i.e., expectation concerning the ease of initiating certain traffic behavior), and moral obligation affect behavioral intention, which then evokes certain traffic behaviors. A similar model may apply to driver horn use as a traffic behavior. Therefore, we used five questions to evaluate respondent awareness regarding four types of psychological factors in a lower layer of the traffic behavior model, and its effects on driver horn use (i.e., Q5-1 to Q5-5 in Appendix):

Q5-1: Is vehicle horn use good behavior? (question concerning respondent attitude toward horn use)
Q5-2: Can a vehicle horn sound become annoying for people outside the vehicle, such as pedestrians and cyclists? (question concerning respondent’s norm consciousness of horn use).
Q5-3: Can vehicle horn use toward other drivers cause offense to them? (another question concerning respondent’s norm consciousness of horn use).
Q5-4: Do you (respondents) usually honk your horn? (question concerning ease or difficulty of horn use, i.e., perceived behavioral control).
Q5-5: Should traffic regulations, no matter how minor, be obeyed? (question concerning respondent’s ethical viewpoint, i.e., moral obligation).

Fig. 2 Traffic behavior model (drawn from original figure of Fujii (2002)). The model represents that factors including personal attitude (defined as preference), personal norms, perceived behavioral control (i.e., expectation concerning the ease of initiating certain traffic behavior), and moral obligation affect behavioral intention, which then evokes certain traffic behaviors.

For each question, respondents answered regarding their awareness using five Likert-type scale categories (1 to 5), in which both extremes for each question corresponded to “strongly agree” and “strongly disagree”.

The questionnaire survey was done in two cities of South Korea, Seoul and Busan, which are the capital and
second-largest city of the country, respectively. In the surveys of both cities, questionnaire forms were distributed to participants by cooperators in the present study. All participants provided informed consent and were not given financial incentives to participate. They were asked to fill out the questionnaire at home. Our cooperators received the filled-in questionnaire forms from participants after about 2–5 weeks. We obtained questionnaire answers from 123 participants living in Seoul and its suburbs, and 57 participants in Busan. After eliminating blank forms submitted by two participants in Busan, responses of 178 participants were analyzed. All responses were examined together with the following procedures, because no significant difference in results of a driver’s own horn use between the two cities was found through a chi-square test ($\chi^2 = 31.1$, d.f. = 37, not significant, indicated by n.s.).

One hundred and two males and 76 females (57.3% and 42.7% of the total 178 respondents, respectively) in their teens through seventies participated (teens, 1.1%; twenties, 47.8%; thirties, 19.1%; forties, 20.2%; fifties, 9.6%; sixties, 1.1%; seventies and over, 1.1%). Respondents mainly comprised salaried workers and students (self-employed person, 6.7%; salaried worker, 36.5%; independent professional, 3.4%; full-time housewife, 5.6%; part-time worker, 0.0%; student, 41.6%; person without a regular occupation, 1.1%; other, 4.5%; no answer, 0.6%).

### 3.2 Results

#### 3.2.1 Simply totaled results of vehicle horn use

Table 1 presents simply totaled results concerning vehicle horn use. There were 98 drivers among the respondents. Of these drivers, 89 recalled using their horn while driving (Group I, as defined in Sect. 3.1). Additionally, 85 had experiences of being honked at by another driver (Group II). There were 91 respondents who recalled being honked at while walking (Group III).

Regarding the reason for horn use (intent of use), more than half the 89 drivers in Group I honked to gain another’s attention or to alert another to danger while driving (for Group I, to gain another’s attention: 22.5%, to inform of danger: 46.1%). Moreover, many drivers experiencing being honked at for similar purposes (for Group II, to gain another’s attention: 30.6%, to inform of danger: 28.2%).

There were a few drivers who had used their horn to express gratitude and had experiences of being honked at for a similar purpose (4.5% of Group I and 3.5% of Group II). Although many cases in which drivers honked their horn to express gratitude were reported in Japan (Takada et al., 2013, 2014), the present results suggest that such horn use is uncommon among drivers in the surveyed areas. There were more than a few cases in which drivers used their vehicle horn to vent anger and in which drivers were honked at by another driver for a similar reason (to vent anger: 11.2% of Group I and 14.1% of Group II).

Many pedestrians had experienced being honked at by a driver to alert them to danger, to gain their attention, or to vent anger (for Group III, to inform of danger: 49.5%, to gain another’s attention: 17.6%, and to vent anger: 16.5%).

Concerning the types of honking, a single honk or two short honks (onomatopoeically represented by “puQ” and “puQ puQ,” respectively) were more frequently used than long honks (onomatopoeic representations such as “puuu” and “puuu puuu”). Specific results were for a single honk and two short honks: 52.8% and 23.6% of Group I, 29.4% and 37.6% of Group II, 29.7% and 38.5% of Group III; a long honk and two long honks: 18.0% and 1.1% of Group I, 22.4% and 2.4% of Group II, 23.1% and 1.1% of Group III. The survey reveals many cases in which pedestrians were honked at with long honks by drivers and that the types of honking for drivers and pedestrians in the surveyed areas were similar to those in Japan (Takada et al., 2013, 2014).

These horn uses were in various places from narrow lanes to main roads with various traffic conditions, mainly during daytime and evening.

Regarding the psychological reaction when honked at by a driver, there were more than a few drivers and pedestrians who had no particular feeling (no particular feeling: 16.5% of Group II, and 14.3% of Group III). However, pedestrians more frequently had negative psychological reactions, e.g., they considered the horn to be startling, noisy, or irritating more often than drivers (the sum of the three items “startled,” “sensation of noisiness,” and “irritated” were 48.2% of Group II and 75.8% of Group III), as shown in Table 1.

For the questions regarding sound sources heard at home, 98 respondents recalled hearing horns there. Eighteen respondents declared that they had been annoyed by horn sounds (18.4% of respondents who recalled hearing horns at home). Thirteen of the 18 respondents who had been annoyed by horns were disturbed from their sleep.
Table 1  Rates of responses (%) for questionnaire items in each respondent group (Group I: drivers who used their horn while driving; Group II: drivers who had experiences of being honked at by another driver; Group III: pedestrians who had experiences of being honked at while walking; N: number of respondents, —: no question).

| Questionnaire items                        | Rate of respondents (%) |
|-------------------------------------------|-------------------------|
|                                           | Group I (N=89) | Group II (N=85) | Group III (N=91) |
| Time                                      |              |                |                  |
| Early morning                             | 12.4         | 14.1           | —                |
| Daytime                                   | 50.6         | 57.6           | —                |
| Evening                                   | 24.7         | 23.5           | —                |
| Nighttime                                 | 10.1         | 4.7            | —                |
| Middle of the night                       | 1.1          | 0.0            | —                |
| No answer                                 | 1.1          | 0.0            | —                |
| Place                                     |              |                |                  |
| Narrow lane (neighborhood road)           | 25.8         | 12.9           | —                |
| One-lane road (without separation between opposing traffic) | 9.0         | 11.8           | —                |
| Two-lane road (one lane in each direction) | 23.6        | 38.8           | —                |
| Main road (two lanes or more in each direction, or a national road) | 33.7        | 27.1           | —                |
| Expressway                                | 3.4          | 3.5            | —                |
| Other                                     | 2.2          | 3.5            | —                |
| No answer                                 | 2.2          | 2.4            | —                |
| Target of horn use                        |              |                |                  |
| Car                                       | 73.0         | —              | —                |
| Motorcycle                                | 2.2          | —              | —                |
| Cyclist                                   | 1.1          | —              | —                |
| Pedestrian                                | 18.0         | —              | —                |
| Other                                     | 3.4          | —              | —                |
| No answer                                 | 2.2          | —              | —                |
| Traffic volume                            |              |                |                  |
| Respondent’s and another driver’s car only | 39.3        | 28.2           | —                |
| A few cars in front and behind            | 21.3         | 28.2           | —                |
| Many cars                                 | 20.2         | 24.7           | —                |
| Traffic congestion                        | 7.9          | 12.9           | —                |
| Other                                     | 2.2          | 2.4            | —                |
| No answer                                 | 9.0          | 3.5            | —                |
| Intent of horn use                        |              |                |                  |
| To express gratitude                      | 4.5          | 3.5            | 1.1              |
| To gain another’s attention               | 22.5         | 30.6           | 17.6             |
| To inform of danger                       | 46.1         | 28.2           | 49.5             |
| To vent anger                             | 11.2         | 14.1           | 16.5             |
| Incomprehensible                          | —            | 15.3           | 11.0             |
| Other reasons                             | 4.5          | 5.9            | 4.4              |
| No answer                                 | 11.2         | 2.4            | 0.0              |
| Timing pattern of honking                 |              |                |                  |
| Single honk                               | 52.8         | 29.4           | 29.7             |
| Two short honks                           | 23.6         | 37.6           | 38.5             |
| Three or more short honks                 | 1.1          | 4.7            | 6.6              |
| Long honk                                 | 18.0         | 22.4           | 23.1             |
| Two long honks                            | 1.1          | 2.4            | 1.1              |
| Three or more long honks                  | 2.2          | 3.5            | 0.0              |
| Other                                     | 0.0          | 0.0            | 0.0              |
| No answer                                 | 1.1          | 0.0            | 0.0              |
| Psychological reaction when honked at      |              |                |                  |
| No particular feeling                     | —            | 16.5           | 14.3             |
| Startled                                  | —            | 23.5           | 37.4             |
| Sensation of noisiness                    | —            | 15.3           | 18.7             |
| Irritated                                 | —            | 9.4            | 19.8             |
| Feeling sorry for blocking another driver’s way | —        | 34.1           | 8.8              |
| Comfortable                               | —            | 0.0            | 0.0              |
| Other                                     | —            | 1.2            | 1.1              |
| No answer                                 | —            | 0.0            | 0.0              |
3.2.2 Simply totaled results of driver awareness about vehicle horn use

Table 2 shows simply totaled results of driver awareness about vehicle horn use from 98 drivers. According to the results of respondent attitudes toward horn use (i.e., Q 5-1), there were more drivers with positive attitudes than those with negative ones (“agree”, 37.8%; “disagree”, 29.6%). Comparing results for the question regarding respondent norm consciousness of horn use toward people other than drivers (Q 5-2) with similar results for drivers (Q 5-3), it was found that there were more drivers who were conscious of other drivers’ annoyance than those who were conscious of people other than drivers, such as pedestrians and cyclists (“strongly agree” and “agree” of Q 5-2, 47.0%; similar responses to Q 5-3, 72.4%). With respect to the ease or difficulty of vehicle horn use for drivers (Q 5-4), many drivers responded that they did not often use their horn (“disagree” and “strongly disagree”, 84.7%). This result suggests that respondents were reluctant to use their horns. Concerning respondent’s ethical viewpoint (Q 5-5), the majority of drivers participating in the survey believed that traffic regulations should be obeyed (“strongly agree” and “agree”, 87.8%).

Table 2 Rates of responses (%) on driver awareness of vehicle horn use. Q 5-1 is the question concerning respondent attitude toward horn use (“Is vehicle horn use good behavior?”). Q 5-2 is the question concerning respondent’s norm consciousness of horn use (“Can a vehicle horn sound become annoying for people outside the vehicle, such as pedestrians and cyclists?”). Q 5-3 is another question concerning respondent’s norm consciousness of horn use (“Can vehicle horn use toward other drivers cause offense to them?”). Q 5-4 is the question concerning ease or difficulty of horn use, i.e., perceived behavioral control (“Do you usually honk your horn?”). Q 5-5 is the question concerning respondent’s ethical viewpoint, i.e., moral obligation (“Should traffic regulations, no matter how minor, be obeyed?”).

|       | Strongly agree | Agree | Neither agree nor disagree | Disagree | Strongly disagree | No answer |
|-------|----------------|-------|--------------------------|----------|------------------|-----------|
| Q5-1  | 0.0            | 37.8  | 26.5                     | 29.6     | 0.0              | 6.1       |
| Q5-2  | 4.1            | 42.9  | 13.3                     | 34.7     | 0.0              | 5.1       |
| Q5-3  | 2.0            | 70.4  | 9.2                      | 13.3     | 0.0              | 5.1       |
| Q5-4  | 1.0            | 4.1   | 5.1                      | 56.1     | 28.6             | 5.1       |
| Q5-5  | 23.5           | 64.3  | 4.1                      | 3.1      | 0.0              | 5.1       |

4. Analysis
4.1 Manner of driver horn use

To address relationships between the manner of driver horn use and various factors, such as traffic conditions and driver intent, questionnaire results of Group I were cross-tabulated between questionnaire items concerning vehicle horn use. Statistical testing using Cramer’s V (Cramer, 1966), a statistic measuring the strength of association between nominal variables, was conducted to examine the significant relationships. If V is close to zero, the association between two nominal variables is weak. V close to 1 indicates a strong association between the two variables. As a result, we found no significant relationships between questionnaire items related to driver horn use at a 0.05 significance level. Accordingly, the statistical testing implies no particular manner of honking (e.g., short honks to express gratitude or gain another’s attention). However, the cross-tabulation should describe the current state of driver horn use. Therefore, results of that tabulation are discussed in the following.

Figure 3 illustrates relationships between the location and timing pattern of horn use, Fig. 4 between the target and timing pattern of horn use, Fig. 5 between the driver’s intent and the timing pattern of horn use, and Fig. 6 between the target and driver’s intent of horn use.

To address relationships between the manner of driver horn use and various factors, such as traffic conditions and driver intent, questionnaire results of Group I were cross-tabulated between questionnaire items concerning vehicle horn use. Statistical testing using Cramer’s V (Cramer, 1966), a statistic measuring the strength of association between nominal variables, was conducted to examine the significant relationships. If V is close to zero, the association between two nominal variables is weak. V close to 1 indicates a strong association between the two variables. As a result, we found no significant relationships between questionnaire items related to driver horn use at a 0.05 significance level. Accordingly, the statistical testing implies no particular manner of honking (e.g., short honks to express gratitude or gain another’s attention). However, the cross-tabulation should describe the current state of driver horn use. Therefore, results of that tabulation are discussed in the following.

According to the results of the cross-tabulations, single honks or two short honks were frequently used to alert another to danger or gain another’s attention. In Japan, such horn use was also used to express gratitude (Takada et al., 2013, 2014). Driver horn use for a similar reason was rarely found in the present survey. Horn use to express gratitude may not be widely practiced among drivers in the survey areas. A long honk was sometimes used not only to alert another to danger but to vent anger.

According to both Figs. 4 and 6, drivers stated that they frequently honked at another driver using short honks (a
single honk or two short honks) or a long honk for alerting them to danger and gaining their attention, or to vent anger. Furthermore, drivers occasionally honked at pedestrians using short honks to alert them to danger, although they mainly directed their horn at other cars.

**4.2 Effects of vehicle horn use on the driver and pedestrian psychological reactions**

The type of honking and another driver’s intent of horn use are assumed to arouse various psychological reactions in people hearing a horn (i.e., other drivers and pedestrians). Because pedestrians are generally exposed to vehicle horn sounds at high sound pressure levels, they may have negative psychological reactions. Therefore, to investigate the effects of horn use on driver and pedestrian psychological reactions, relationships between questionnaire items were analyzed by cross-tabulation between variables. Examples of such relationships were between another driver’s intent of horn use and driver or pedestrian psychological reaction, and between honking type and those reactions. In the same manner as for the cross-tabulated results of driver horn use mentioned above, statistical testing using Cramer’s V was performed to find the significant effects of horn use.

**4.2.1 Driver psychological reactions to another driver’s vehicle horn use**

As a result of cross-tabulation of driver psychological reactions, no significant relationships were found at a 0.05 significance level. However, the cross-tabulation should show the effects of another driver’s horn use on driver psychological reactions.

Figure 7 shows the relationship between another driver’s intent of horn use, as deemed by the respondent (i.e., driver), and the respondent psychological reaction when honked at. Drivers were mainly honked at by another driver to gain their attention or alert them to danger. Such horn use aroused various psychological reactions such as no particular
feeling, feeling startled, or feeling sorry for blocking another driver’s way. The absence of significant statistical results (according to Cramer’s V) suggested no particular tendency (Fig. 7).

Figure 8 depicts the relationship between the timing pattern of honking and respondent psychological reaction when honked at, which was again not statistically significant. Short honks such as a single honk followed by two short honks aroused driver psychological reactions such as no particular feeling or feeling sorry for blocking another driver’s way, as well as negative psychological reactions (feeling startled, a sensation of noisiness and feeling irritated). Similar reactions were induced by a long honk.

The results of driver psychological reactions and of driver horn use presented in the previous section suggest that there is no definite manner of driver horn use, so the vehicle horn is not used for communication between drivers. In Japan, drivers frequently use their horn in this way, e.g., when a driver briefly honks after being given the right of way by another driver on a narrow road (Takada et al., 2013, 2014). Such horn use was rarely found in the present survey.

![Fig. 7](image1)
![Fig. 8](image2)

**4.2.2 Pedestrian psychological reactions to vehicle horn use**

Regarding pedestrian psychological reactions, we found significant ($p < 0.05$) effects of driver horn use directed at pedestrians.

Figure 9 shows the significant relationship between driver intent of horn use, as regarded by the respondent (i.e., pedestrian), and the respondent psychological reaction when honked at ($V = 0.271$, not significant). Each bar represents the number of respondents for each driver’s psychological reaction induced by another driver’s horn use with each intent.

Figure 10 indicates the significant relationship between the timing pattern of honking and respondent (i.e., pedestrian) psychological reaction when honked at ($V = 0.301$, $p < 0.05$). Short honks such as a single honk and two short honks aroused various psychological reactions in pedestrians. According to both Figs. 9 and 10, although there were some cases in which short honks used to gain a pedestrian’s attention or alert them to danger induced no particular feeling, there were many cases in which pedestrians were startled by short honks intended to alert them to danger. A long honk provoked negative psychological reactions in pedestrians, for any purpose of horn use.

The finding that pedestrians were negatively affected by horn use was similar to that for Japan (Takada et al., 2013, 2014). According to a comparison of the present results of pedestrian and driver psychological reactions to vehicle horn use (see Figs. 7–10) and the simply totaled results (Table 1), horn use aroused negative psychological reactions much more in pedestrians than in drivers. A likely reason is the difference in sound level of a horn inside and outside a vehicle. Pedestrians are generally exposed to a horn with high sound pressure level that is approximately 40 dB higher than the sound heard by a driver inside a vehicle (Takada et al., 2010). Drivers should be aware that a vehicle horn directed at pedestrians will generate adverse psychological reactions.
4.3 Psychological factors affecting driver horn use

To address the intrinsic factors of drivers such as attitude, personal norms (i.e., social motive or another person’s appreciation) and moral obligations (i.e., ethical viewpoints) affecting his or her own horn use, relationships between questionnaire items were analyzed by cross-tabulation between variables. An example of such relationships was between respondent awareness about driver horn use and the manner of its use (questionnaire results of Group I), such as the intent and type of honking. Statistical testing using Cramer’s V was carried out to find the significant effects of the intrinsic factors of drivers on their horn use.

As a result of cross-tabulation, we found a significant relationship between driver awareness concerning ease or difficulty of vehicle horn use (Q5-4) and the intent of that use ($V = 0.309, p < 0.05$, Fig. 11). There were many cases in which drivers who did not usually use their horn honked to alert another to danger or gain their attention. The relationship between driver awareness regarding ease or difficulty of horn use (Q5-4) and the timing pattern of honking was also statistically significant ($V = 0.447, p < 0.05$, Fig. 12). Most drivers who did not usually use their horn mainly used short honks, such as a single and two short honks or sometimes a long honk. Conversely, drivers who usually used their horn seemed to do long honks, such as a long honk and three or more long honks, although a small number of such cases were found.

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**Fig. 9** Relationship between driver intent of horn use, as deemed by pedestrians, and their psychological reactions when honked at ($V = 0.363, p < 0.05$). Each bar represents the number of respondents for each pedestrian’s psychological reaction induced by driver’s horn use with each intent.

**Fig. 10** Relationship between timing pattern of honking and pedestrian psychological reactions when honked at ($V = 0.301, p < 0.05$). Each bar represents the number of respondents for each pedestrian’s psychological reaction induced by each type of horn honking.

**Fig. 11** Relationship between driver awareness concerning ease or difficulty of vehicle horn use (Q5-4) and their intent of use ($V = 0.309, p < 0.05$). Each bar represents the number of honking with each intent of respondents who had awareness concerning ease or difficulty of vehicle horn use.

**Fig. 12** Relationship between driver awareness concerning ease or difficulty of vehicle horn use (Q5-4) and timing pattern of honking ($V = 0.447, p < 0.05$). Each bar represents the number of each honking type used by respondents who had awareness concerning ease or difficulty of vehicle horn use.
Q5-4 was used to investigate the intrinsic factor of respondents regarding perceived behavioral control (i.e., expectation concerning the ease of initiating certain traffic behavior) in their own horn use. In the relevant traffic behavior model (Fig. 2), therefore, the perceived behavioral control of the driver’s intrinsic factors was interpreted as significantly affecting their horn use as traffic behavior. Respondents who denied frequent horn use (i.e., those who answered “disagree” and “strongly disagree” to Q5-4) had difficulties using their horn. These results suggest that drivers who did not usually honk were reluctant to use their horn, and that they briefly honked to alert another to danger or gain their attention out of necessity. It may therefore be interpreted that the feeling of reluctance restrains their liberal horn use.

5. Discussion

Korean road traffic act prohibits drivers from generating any noise that damages other persons such as repeated or continuous horns without justifiable grounds (National Police Agency of South Korea, 2015). The points of this law are similar to those of Japanese road traffic law. Although the majority of drivers briefly honked to alert another to danger or gain their attention out of necessity according to this law, they occasionally honked, not only at drivers but also pedestrians. The present results concerning psychological reactions to vehicle horn use revealed that horn use aroused negative psychological reactions much more in pedestrians than in drivers. Psychoacoustic studies concerning effects of the acoustic properties of horn sound on auditory impressions, in which all of the participants were Japanese, also reported similar results (Takada et al., 2010; Takayama et al., 2012). Moreover, results of these psychoacoustic studies revealed that auditory impressions (i.e., pleasantness and annoyance) became worse as the number of honking increased, and even a single honk aroused negative impressions in the pedestrian condition. Given the high sound level of vehicle horns, it is natural that pedestrians have negative perceptions of vehicle horns. Although a proposal for reduction of the lower limit of the noise level in the current international standard was submitted (Economic and Social Council of United Nations, 2014), it may be necessary to conduct further investigation of the volume of vehicle horns (particularly the higher limit of the noise level). It should at least be emphasized that drivers should not honk at pedestrians and cyclists.

Measurements of road traffic noise including vehicle horn sounds at crossroads were limited in area. However, in the survey areas, we found frequent horn use and many cases of such use caused by the traffic regulation allowing drivers to turn right at a crossroads even if the traffic light controlling traffic flow straight ahead is red. Questionnaire results also indicated that driver horn use and experiences of being honked at to gain another’s attention or alerting to danger were frequent (Table 1). Considering these results, an amendment of related traffic regulations, so that drivers are prohibited not only to go straight but also to turn right at a crossroad if the traffic light controlling traffic flow straight ahead is red, may reduce driver horn use in such situations.

In the traffic psychological research on aggressive driving, driver horn use was regarded as a behavior reflecting aggression (Shinar, 1998). Further, this research addressed effects of various factors such as time pressure or congestion (e.g., driving in weekday work-hour traffic or on weekends), duration of traffic signal green phase, road type, and personal attributes on driver horn reaction time when waiting behind a car that fails to start after the traffic signal change to green. According to this research, factors affecting driver aggression may be related to the manner of driver vehicle horn use. Consequently, in the present study, relationships between that manner (timing pattern of horn honking in Group I) and situations of use such as time and place, which approximately correspond to factors of “time pressure or congestion” and “road type” in the traffic psychological research (Shinar, 1998), were not statistically significant (time vs. timing pattern: V=0.198, n.s., figure not presented; place vs. timing pattern: V=0.152, n.s., Fig. 3). Road type should affect whether drivers use their horn, but should not be related to the manner of horn use.

In questions concerning the manner and driver awareness of horn use, drivers might answer politely. There were actually a few respondents who answered their negative attitudes towards horn use and driving (see Table 2). Such respondents’ attitudes might give biased results in Figs. 11 and 12. However, we found that the perceived behavioral control of the driver’s intrinsic factors was significantly correlated with the manner of their horn use, such as the intent of that use and the timing pattern of honking. The significant relationships suggest that a driver’s feeling of reluctance to use the horn restrains this use for purposes other than original intentions, such as warning others of danger or avoiding such situations. Accordingly, as a countermeasure to reduce driver horn use, arousal of the driver’s feeling of reluctance in horn use seems to be effective. Consequently, it is necessary to make drivers understand the adverse
impacts of the horn sound on individuals honked at (especially pedestrians), and to encourage drivers to keep their horn use to a minimum. According to the simply totaled results, around 20% of respondents who recalled hearing vehicle horns at home felt annoyed by them. Not a few residents or workers in neighborhoods with crossroads may be continually annoyed by frequent horn use. An approach to control frequent driver horn use may improve the noise problem related to horn sounds, in which people other than drivers are annoyed.

Some cross-cultural studies on driving behavior have indicated that whether vehicle horn use reflecting driver aggression was observed was dependent on country or region (Lajunen et al., 2004; Özkan et al., 2006). Extended studies using people with various attributes and residence areas may reveal whether other intrinsic factors of drivers, such as norm consciousness and moral obligation, affect their own horn use. Furthermore, it is possible that other extrinsic factors of drivers such as traffic regulation of horn use and social customs in traffic influence that use.

6. Conclusions

Noise measurements at crossroads in Seoul, South Korea, revealed frequent horn use, although there were differences in frequency depending on the day of measurement. Mean noise levels of vehicle horn sounds measured at the sites were around 71–75 dB.

The questionnaire survey revealed that drivers frequently honked at another driver with short honks or a long honk, not only to alert them to danger and gain their attention but also to vent anger. Few drivers used their horn to express gratitude, although such horn use was widespread among drivers in Japan (Takada et al., 2013, 2014). Furthermore, another driver’s horn use to gain attention and to alert people to danger aroused various psychological reactions, such as feeling startled or feeling sorry for blocking another driver’s way; however, some did not have any particular feelings. There were no significant relationships between questionnaire items concerning driver use of the horn, suggesting that there may be no definite manner of that use in urban areas of South Korea. The results suggest that the vehicle horn is not used in communicating with other drivers. Moreover, significant negative effects of driver horn use on pedestrians were also found. Drivers must understand the adverse impacts of the horn sound, especially on the pedestrians honked at.

The present questionnaire form also included questions on respondent awareness of their own horn use. Correlation results between driver awareness of their horn use and its manner suggested that drivers who did not usually honk were reluctant in that use, and that they briefly honked to alert another to danger or gain their attention out of necessity.

The present study partially revealed the current state of vehicle horn use in the surveyed areas. However, regarding the intrinsic factors of respondents, only the effect of the perceived behavioral control factor (i.e., expectation concerning the ease of initiating certain traffic behavior) on driver horn use was found. Questionnaire surveys for people with various attributes and areas of residence may reveal general tendencies of driver horn use. Furthermore, as stated in prior traffic psychological research on driving behavior (Lajunen et al., 2004; Özkan et al., 2006), if there are regional differences in horn use, global surveys are needed.

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Appendix

PQ. We would like to ask you about yourself. Please circle the appropriate choice in the following items.

- Gender
  - [ female   male ]

- Age
  - [ teens twenties thirties forties fifties sixties seventies and over ]

- Occupation
  - [ self-employed person   salaried worker   independent professional   full-time housewife   part-time worker   student   person without a regular occupation   other (       ) ]

Q0. Do you have a driving license? If your answer is “yes”, please circle the appropriate choice in the following questions.

- Frequency of driving
  - [ everyday a few times a week once a week a few times a month a few times a year ]

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Q1. This question is for drivers only. Do you have any experience of honking at? If your answer is “yes”, please circle the appropriate choice in the following details about the latest or last-remembered case.

- **Time**
  - early morning
  - daytime
  - evening
  - nighttime
  - middle of the night

- **Place**
  - narrow lane
  - one-lane road
  - two-lane road
  - main road
  - expressway
  - other ( )

- **Target of horn use**
  - respondent’s and another driver’s car only
  - a few cars in front and behind
  - many cars
  - traffic congestion
  - other ( )

- **Intent of horn use**
  - to express gratitude
  - to gain another’s attention
  - to inform of danger
  - to vent anger
  - other ( )

- **Type of honking**
  - single honk
  - two short honks
  - three or more short honks
  - long honk
  - two long honks
  - three or more long honks
  - other ( )

Q2. This question is for drivers only. Do you have any experience of being honked at by another driver while driving? If your answer is “yes”, please circle the appropriate choice in the following details about the latest or last-remembered case.

- **Time**
  - early morning
  - daytime
  - evening
  - nighttime
  - middle of the night

- **Place**
  - narrow lane
  - one-lane road
  - two-lane road
  - main road
  - expressway
  - other ( )

- **Traffic volume**
  - respondent’s and another driver’s car only
  - a few cars in front and behind
  - many cars
  - traffic congestion
  - other ( )

- **Intent of horn use**
  - to express gratitude
  - to gain another’s attention
  - to inform of danger
  - to vent anger
  - incomprehensible
  - other ( )

- **Type of honking**
  - single honk
  - two short honks
  - three or more short honks
  - long honk
  - two long honks
  - three or more long honks
  - other ( )

- **How did you feel when honked at?**
  - no particular feeling
  - startled
  - sensation of noisiness
  - irritated
  - feeling sorry for blocking another driver’s way
  - comfortable
  - other ( )

Q3. Do you have any experience of being honked at by a driver while walking? If your answer is “yes”, please circle the appropriate choice in the following details about the latest or last-remembered case.

- **Type of honking**
  - single honk
  - two short honks
  - three or more short honks
  - long honk
  - two long honks
  - three or more long honks
  - other ( )

- **Driver’s intent of horn use**
  - to express gratitude
  - to gain another’s attention
  - to inform of danger
  - to vent anger
  - incomprehensible
  - other ( )

- **How did you feel when honked at?**
  - no particular feeling
  - startled
  - sensation of noisiness
  - irritated
  - feeling sorry for blocking another driver’s way
  - comfortable
  - other ( )

Q4. How do you feel about the volume and sound quality of vehicle horns? Please circle the appropriate choice in each item.

- **Volume**
  - too loud
  - fairly loud
  - moderate
  - fairly low
  - too low
Sound quality
[ good unpleasant insufficient neither good nor bad indifferent other ( ) ]

Q5. This question is for drivers only. Please circle the appropriate number on the five Likert-type scale categories in the following questions.

Note: 1 = “Strongly agree”, 2 = “Agree”,
3 = “Neither agree nor disagree”,
4 = “Disagree”, 5 = “Strongly disagree”

Q5-1. Is vehicle horn use good behavior?

Q5-2. Can a vehicle horn sound become annoying for people outside the vehicle, such as pedestrians and cyclists?

Q5-3. Can vehicle horn use toward other drivers cause offense to them?

Q5-4. Do you usually honk your horn?

Q5-5. Should traffic regulations, no matter how minor, be obeyed?

GQ1. Are the following sounds audible in your house? Are you annoyed by the sounds? Please mark in the appropriate column.

| No | Sound source                                         | inaudible | audible |
|----|----------------------------------------------------|-----------|---------|
|    |                                                    | not annoying | annoying |
GQ2. In which way are you annoyed by car horns in GQ1? Please circle the appropriate choices. You can mark as many as you like.

(   ) The sound is a little annoying, but not so serious.
(   ) I cannot relax because of the sound.
(   ) The sound is irritating.
(   ) The sound makes me unhealthy.
(   ) The sound disturbs listening to telephone, television, or radio.
(   ) The sound disturbs working or reading.
(   ) The sound disturbs conversation.
(   ) The sound disturbs sleep.
(   ) other (           )

GQ3. At what time of day are you annoyed by car horns? Please circle the appropriate choice.

[ early morning   daytime   evening   nighttime   middle of the night   whole day   not fixed ]