

MULTIPLE TRAFFIC SAFETY BEHAVIOR ENCOURAGED BY THE COLORED PAVEMENT: THEORETICAL FRAMEWORK AND EMPIRICAL VALIDITY

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ABSTRACT

Aoki(2009) reported that colored pavement would encourage safe driving for drivers on both non-colored and colored roads. Aoki, however, does not elaborate on the mechanisms present in that effect. Hence, this study, referring to psychological theories, aims to verify the psychological processes involved in the effects of colored pavement on safe driving..

Based on both mere exposure theory and brand priming theory, the following hypotheses are set: After people drive on colored pavement many times, understanding the meanings of the pavement, they would develop positive responses to the colored pavement(H1), and would drive safer than before(H2). Encountering the colored pavement regularly,would enhance their awareness of safety while driving(H3). As a result, drivers who drive in colored zones habitually would begin to drive safer than before, even on non-colored roads(H4).

In order to test the above reasoning, I conducted a questionnaire survey on residents who live in an area where colored pavement has been introduced, measuring select psychological variables. The survey reveals that the colored pavement encourages residents to drive safely not only in the colored zones, but also out colored zones. Hence the safe driving effect of colored pavement was confirmed again. Furthermore, conducting a structural equation modelling revealed that the model based on the above reasoning was supported statistically. Hence, it can be concluded that the colored pavement could be one of the most economical and effective countermeasures for safe driving.

Keywords: road safety, brand priming effect, mere exposure effect, safe driving, colored pavement

INTRODUCTION

Low-cost countermeasures for road safety are gradually becoming more and more important in Japan due to financial issues and the increase in traffic accidents of elderly drivers. Hence, various countermeasures such as a colored pavement, transverse lines, warning signs, narrowed roads, rumble strips, etc. have been implemented for speed reduction. Most of the studies on those countermeasures, however, focus on transverse lines for speed reduction (Van der Heijden, 1978; Lum, 1984; Jamson, Pyne, & Carten, 1999; Denton, 1980; Agent, 1980; Maroney & Dewar, 1987; Godley et al, 1997; Retting, McGee, & Farmer, 2000; Lene, 2005), and they do not have a clear theoretical framework. In addition, the impact of transverse lines is limited in constructed zones. And, a few empirical studies suggest that the impact of colored pavement could be limited in the colored zone (MLIT Tohoku regional bureau, 2005, 2006). Hence, it is necessary to explore, from a theoretical standpoint, countermeasures that have a decisive impact on road safety.

Under such circumstances, Aoki (2009) reports that colored pavement, which is called "Danger Zone Pavement (DZP)", has had a greater impact on driving safety than what was expected. He found that people who drive on the colored pavement frequently came to drive safer than before, not only in the zone, but also out of the zone. That is, DZP encourages people to drive safer even out of the colored zone. However, the theoretical framework and justification of the impact has not been clarified. Hence, this study aims to explain the impact from a theoretical and empirical perspective. Note that the difference between normal colored pavement and DZP is in intelligibility against meaning of the colored pavement. DZP is the umbrella term for colored pavement (red brown) with public participation system in its construction process. That is, citizens are encouraged to voice their opinion about the colored pavement in that construction process.

THEORETICAL FRAMEWORK AND HYPOTHESES

Theoretical framework

Considering that driving is a behaviour and a behaviour has close relationship with psychology, one method to encourage safe driving could be based on psychology. Hence, thus far, the Theory of Planned Behaviour (TPB) has been often applied to safe driving factors such as speed reduction (Paris & van den Broucke, 2007; Warner & Aberg, 2006, 2008; Victoir et al, 2005; Rothengatter, 2003; Letirand & Delhomme, 2005; Mannering, 2008; Falk & Montgomery, 2007). These studies report the validity of TPB, and emphasize subjective norms for safe driving. The Framework of TPB, however, does not provide an acceptable explanation of the impact of the DZP, because it is difficult to describe the psychological processes that occur between environmental stimulus and behaviour change. In particular, TPB is not effective when describing detailed processes in attitude change that could occur as a result of environmental changes. Hence this study needs to employ another theoretical framework in order to explain the impact of the DZP.

Here, considering features of respondents in Aoki's questionnaire survey (Aoki, 2009), two features are highlighted: high intelligibility and high frequency driving for the colored zone. When governmental authorities planned to construct the DZP in Nishikawa town, Yamagata

prefecture, they invited public participation when they decided on some aspects of the DZP, such as the color of the pavement, length of the zone, design of warning signs. etc. Hence, the characteristics of the DZP is in public participation system in its construction process.

In the process, the authority made a broad appeal to the DZP. Hence, almost all residents in the town know its meaning. On the other hand, as the DZP was constructed on the main street in the town, many residents would pass through the zone frequently. As these two points, high intelligibility and high frequency driving, are the distinctions of the DZP, this study needs to employ a theoretical framework related to those two aspects: mere exposure theory and brand priming theory.

Mere exposure theory

Mere exposure theory was proposed by Zajonc(1968), and is one of the most commonly applied theories to attitude change. According to this theory, an individual can have a positive attitude after he/she contacts a stimulus repeatedly. In other words, being exposed to a stimulus often enough encourages one to have a positive attitude to the stimulus. This study employs this theoretical framework to explain the impact of driving frequency in the DZP on safe driving.

Brand priming theory

Brand priming theory was proposed in the consumer research field in 2008(Fitzsimons et al, 2008) and is one of the latest theories. This theory argues that individuals who are exposed to brand logos behave consistently with the underlying message that the brand is propagating. Furthermore, the theory suggests that such behavior occurs automatically. For instance, people who have been exposed to Apple logos become more creative than those exposed to IBM logos. Therefore, this theory suggests that people's behavior tend to be consistent with the meaning of the stimulus. The current stud employs this framework to explain the impact of the meaning of DZP on safe driving.

Hypotheses

With the two theoretical frameworks above, the impact of the DZP on safe driving could be analyzed theoretically. Following mere exposure theory, people who pass the DZP on a regular basis have a positive attitude toward it due to the frequency of exposure. In addition, considering that most residents in the area understand the meaning of the DZP,(in essence to drive carefully), drivers who live in there would reduce their speed out of habit due to the psychological mechanisms at work. On this occasion, as the tendency to elude cognitive dissonance(Festinger, 1957) between positive attitudes to the DZP and their driving manner, they would, as a consequence, come to decrease their speed. In other words, understanding of the meaning of DZP encourages people to drive safely, and approval attitude against the DZP could reinforce the change to safe driving. In addition, as people experience such change repeatedly, their self-concept of safe driving would change to be consistent with approval attitude against the safe driving well, because self-concept is a construct that refers to an individual's perception of "self", and one of the fundamental factors

that has great influence on one's behavior(Niedenthal et al, 1985). That is, while high intelligibility for the meaning of the DZP encourages resident driver driving safer, frequent driving on the DZP helps to form positive attitude against the DZP, then, the positive attitude could reinforce the change to safer driving. On that process, self-concept could change to be consistent with safer driving. Once self-concept has changed, such people would drive safely in their daily life. Hence, people would come to drive safely even on the non-colored pavement . In order to verify this hypothesis, a questionnaire survey was conducted.

METHOD

Questionnaire survey

A questionnaire survey was conducted targeting drivers who live in Nishikawa town. I asked community leaders to deliver the questionnaire via the local government. The survey was conducted in January, 2010.

Measures

The questionnaire concludes items related to perception of the DZP, frequency of passing the DZP, intelligibility against the meaning of the DZP, driving attitude before DZP construction, driving attitude after DZP construction, self-concept before DZP experience, self-concept after DZP experience, driving manner on a general road, specifics of safe driving and demographic variables such as age, sex, and residential area. Most of these items are measured using a 6pointed-Likert scale ranging from "1: strongly disagree" to "6: strongly agree", except for Q1, Q2 and demographic variables. Table-1 shows the items and specific questions.

Table I – Main items of the questionnaire survey

Items	Questions	No.
Perception	Are you aware that road zone near Kaishu post office are colored as red brown?	Q1
Frequency of passing	How many days do you drive on the colored pavement near Kaishu post office in a week?	Q2
Attitude to DZP	The colored pavement is helpful as a countermeasure for road safety.	Q3
	The colored pavement should be familiarized in a dangerous area.	Q4
	The colored pavement could be valid as a countermeasure for road safety.	Q5
Intelligibility	The colored pavement can alert drivers to the presence of pedestrians.	Q6
	The colored pavement was constructed to reduce the speed of drivers.	Q7
Attitude adjustment while driving	I drive much safer in recent days compared to before the colored pavement was introduced.	Q8
	I pay more attention to pedestrians thanks to the colored pavement.	Q9
Safe driving on non-colored roads	I drive as safely as I can, even on non-colored roads.	Q10
	I have become more alert to pedestrians, even on non-colored roads.	Q11
	I have become a safe driver.	Q12
Driving manner before(after) DZP	I thought(think) that a driver should drive safely whenever he/she drives	Q13
	I thought(think) that a driver can increase speed a certain degree,if it is in a manageable level.	Q14
	I did(do) not pay attention to pedestrian so much when I drove(drove).	Q15
	I thought(think) I was(am) a safe driver.	Q16
	I thought(think) that I drove(drove) faster than general drivers.	Q17
	I believed(believe) that I would(will) not have a traffic accident.	Q18
Participation	I believed(believe) that I practiced(practice) forbearance in relation to other cars and pedestrians.	Q19
	Did you attend a meeting to decide the color of the pavement?	Q20
	Did you answer a questionnaire on the specifications of the pavement?	Q21

RESULTS

Outline of the survey

151 questionnaires were delivered via a community leader and 114 were collected by mail(75.5 percent). The mean age of the respondents was 60.4($SD = 15.7$). Respondents consist of 76 males, 36 females, and 2 unknown.

Postulates for the theoretical framework

Frequency of driving on the colored zone

As for the numbers related to the frequency of driving on the DZP, the mean days a week was 4.80. Considering that the usual work week for most is five days a week, this mean value suggests that respondents drive on the zone on their daily commute. Hence, the postulate of frequency in passing through the zone was satisfied the assumption for the theoretical hypothesis.

Intelligibility on the meaning of the colored pavement

First of all, information about the perception of the DZP was obtained with inquiries with four possible answers. As a result, 99.1 percent of the respondents answered that "I have driven on the zone". Hence, at least, it can be said that almost all respondents know the DZP.

Next, as for the meaning of the DZP, ascertained by two questions(Q6 and Q7), mean values were 4.16 and 4.19($SD = 1.46, 1.30$ respectively). These results suggest that respondents mostly understood the meaning of the DZP.

Based on the above, it can be said that respondents satisfied the two postulates for the theoretical framework that is employed here.

Safe driving effect of the colored pavement

Aoki(2009) reported that drivers who pass on the DZP frequently became safer drivers even on non-colored pavement, compared to driving habits before the pavement was constructed. In order to verify that effect, changes in driving manner on normal pavement were illustrated with two questions(Q8 and Q9). The result is shown in Figure 1.

The results confirmed the precedent finding($m = 4.34, 4.35, SD = 1.21, 1.20$ for Q8 and Q9 respectively). That is, most of the respondents showed a change in attitude toward safer driving. In addition, the three questions (Q10, Q11, and Q12), were asked to ascertain driving manner on non-colored pavement. The results also suggest a change in driving manner($m = 4.75, 4.46, 4.06, SD = .75, .98, 1.09$, for Q10, Q11, and Q12 respectively).

These results support my hypothesis that the DZP encourages the safe driving of residents who pass through the zone frequently.

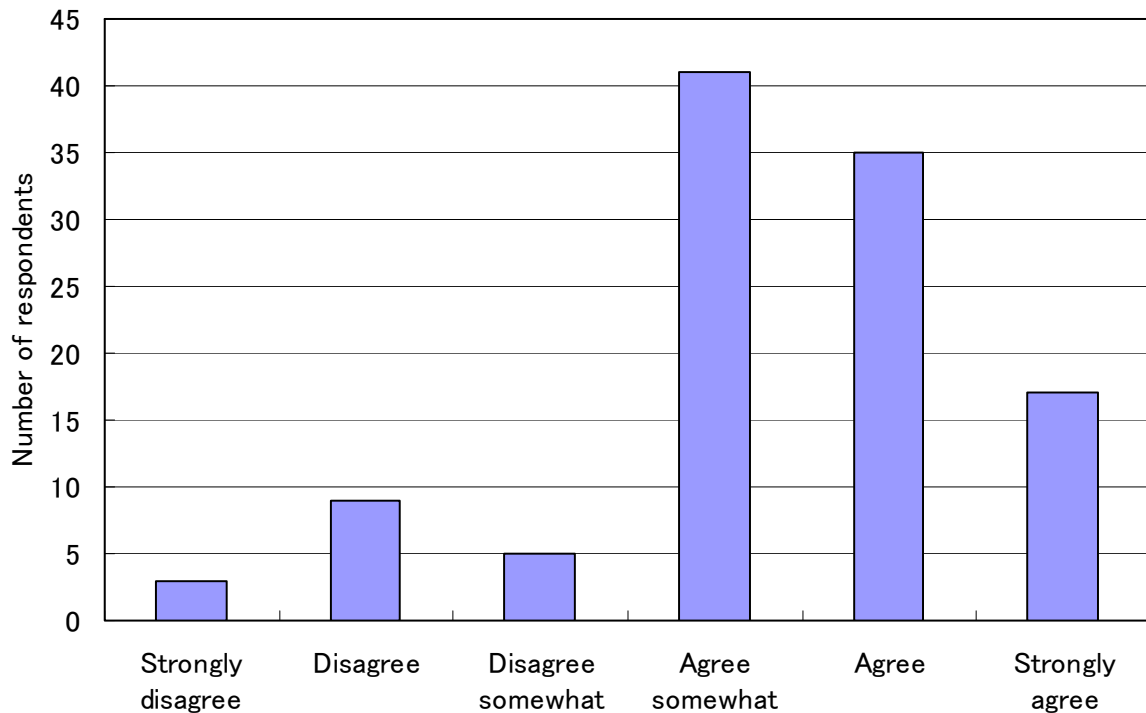


Figure 1 – The safe driving effect based on Q8: The number of drivers who reported becoming safer drivers after the DZP was constructed

The psychological process of the safe driving effect

Structural Equation Modelling(SEM) was applied to test the psychological process as been hypothesized. Table 2 shows the result.

In Figure 2, a square means an observed variable. A circled variable means a construct. A figure near arrows is a standardized partial regression coefficient. A figure on the right of a construct is a determination coefficient. A figure between two constructs is a covariance. Since all parameters in this model are statistically significant and indexes for goodness of fit are quite well, too. this model can be regarded as being worth discussing.

SEM revealed that intelligibility and attitude to the DZP can encourage attitude change in driving manner, as they have a high correlation with it respectively. Furthermore, the model revealed that attitude change in driving can encourage safe driving on non-colored pavement as well. These findings support my hypothesis on the psychological processes involved.

Besides the above, change in self-concept was also analyzed using questions No.13 to No.19. These items were measured by asking participants in the survey to recall situations before/after the DZP construction. Applying a t-test to the data before and after the DZP construction, it found statistical significance on Q13, Q14, and Q19($t(102) = 3.47, p < .001$ for Q18; $t(97) = -2.41, p < .02$ for Q19; $t(96) = 2.69, p < .001$ for Q19). Here, although the result of Q18 has the negative sign, it means change in self-concept toward safe driving, because this question asks excessive confident on safe driving. Hence, this negative sign suggests that drivers became more careful and modest against a traffic accident after the DZP. Other questions on self-concept were not statistically significant. Considering that the questions

that show statistical significance are related to “subjective norm for driving”, it can be interpreted that the DZP changed self-concept concerning driving norm. That is, since subjective norm for safe driving was reinforced, respondents’ driving safety also could change, and finally this change could induce safe driving even on non-colored pavement. The result of SEM and analyses on change in self-concept support my hypothesis.

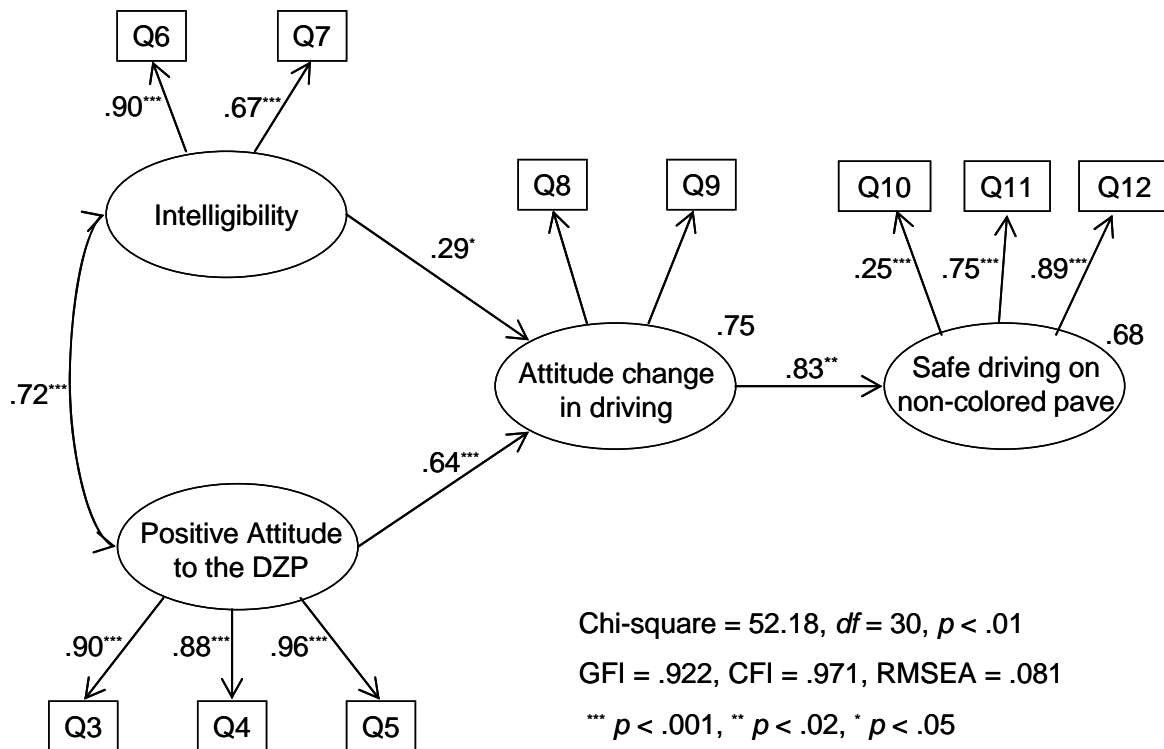


Figure 2 – Psychological process of the safe driving effect

DISCUSSION

The model for the safe driving effect

Basically the hypothetical model was supported by the empirical data. Hence, it can be said that the model for the safe driving effect is valid as a theoretical model. That is, although it is just colored pavement, if people drive on the colored zone frequently and they have knowledge about the meaning of the pavement, the colored pavement can encourage safe driving, not only in colored zones but also on non-colored streets. Considering that this model needs two postulates, frequent exposure to a stimulus and comprehension of the stimulus, this model can be referred to as the “priming exposure model”.

Further, SEM suggests that the causal coefficient between positive attitude and attitude change could be higher than that between intelligibility and attitude change. Applying a z-test to both coefficients, the result shows that the former is greater than the latter ($z = 1.76$, $p < .08$). This result suggests that positive attitude to the DZP could be more important than intelligibility against the meaning of the DZP. Hence, it is difficult to conclude that if only people understand the meaning of the colored pavement, they would come to drive safer automatically. Such change with intelligibility could not occur by only priming effect, it would

need strong impact of positive attitude and cognitive dissonance with the colored pavement. Hence, it would be necessary to conduct further experiments to more fully understand the processes involved in changing attitudes

Applicability and limitation of the model

This model can be applied to various behavior and attitudes in our daily life. For example, it can be applied to shopping behavior, because we are exposed to a lot of advertisements over and over. The possibility of the priming exposure model should be explored in future studies.

On the other hand, this model still has some questions that need verification: Can attitude change be encouraged by only intelligibility or positive attitude in response to a stimulus?; Is intelligibility necessary?; Is attitude change encouraged automatically?. In order to answer these questions, a behavioural experiment, in addition to empirical data analysis would be necessary.

CONCLUSIONS

This study analyzed the validity of a theoretical framework to explain the impact of colored pavement on safe driving on normal pavement. The questionnaire survey and applied statistical analyses yielded the following findings:

If people drive on the colored pavement frequently and are clear as to the message of the pavement, driving safety can be enhanced, not only on the colored zone but also on non-colored streets.

The theoretical framework used to explain the above impact of the colored pavement was formulated, and its validity was confirmed by a t-test and structural equation modelling. As this framework is based on two theories, mere exposure theory and brand priming theory, this model was named the "Priming Exposure Model".

Although the Priming Exposure Model can have great applicability to various behaviours and attitudes, questions on dynamics in behaviour and attitude change process still remain. Hence, behavioural experiments to explain specifics of the dynamics in behaviour and attitude change are indispensable for future study.

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