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## Considering a new framework for designing public safety ‘filler’ messages on highway variable-message signs: Applying the behaviour change wheel

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### Abstract

This paper reviews literature regarding ‘filler’ (particularly safety) messages on variable message signs (VMS), then evaluates the applicability of Michie, van Stralen and West’s behaviour change wheel for message generation using examples from Queensland. Although designed for generating health care interventions, the wheel readily extends itself to road safety. The paper concludes with a brief list of techniques for writing persuasive safety messages. This research was conducted because limited research is available on VMS safety messages or models for their generation. The literature review indicated that although controversy exists regarding the use of VMS for safety messages, more drivers would rather have the messages than blank signs; however, certain messages are seen as more useful than others. Further, VMS safety messages should not be expected to change the behaviour of all drivers but rather help a small share. The key benefit of this paper is that it proposes a comprehensive framework for generating VMS safety messages and describes strategies for writing them. Further research should be conducted on driver reactions to these messages.

### Keywords

Behaviour change wheel, Filler messages, Road safety messages, Variable message signs

### Introduction

Limited research is available on the design, use and effectiveness of ‘filler’ messages on permanently-mounted, highway variable-message signs (VMS) [1-2]. There is even controversy regarding whether these messages should be displayed at all [1,3-4]. In the 2010 Queensland Government Transport and Main Roads (QGTMR) manual titled *Variable message signs use and operation* [5], filler messages include ‘road safety messages, community benefit messages and general transportation messages’ (p.10). In Queensland and many other places, filler messages are displayed on VMS when there are no crashes, roadwork, or important traffic information to report that could influence driving plans. Appendix 1 of this paper presents filler messages listed in the manual, which states that these messages

. . . are displayed when there is no requirement for higher priority messages and are limited to information which is likely to enhance the safety or performance of the state-controlled road network or influence or inform the public in cases of potential or declared natural disasters. Filler messages are not to be displayed when traffic volume exceeds 85% of the road capacity. (pp.11-12)

Figure 1 shows an example of a Queensland VMS that is displaying a filler message. VMS, which are also known as changeable message signs (CMS) or dynamic message signs (DMS), are panels of light emitting diodes (LEDs) on which driver messages can be displayed dynamically.



Figure 1. Example filler message displayed on a VMS along the M1 between Brisbane and the Gold Coast

There is a growing body of evidence that many drivers find VMS helpful when they deliver messages about current driving conditions. For example, in a telephone survey of more than 500 participants in the Washington DC area [6], participants gave nearly unanimous support (97%) for VMS messages that reported the exact locations of crashes so that drivers could decide where to exit and then re-enter the highway. As another example, in a survey of 257 Canadian drivers, 95% of participants agreed that VMS should display advance warnings of delays, crashes, and roadworks [7]. Further, an extensive literature review on VMS noted that these signs deliver many helpful outcomes such as effectively re-routing traffic, reducing driver speed to suit prevailing conditions, and removing congestion [8]. Thus, many drivers believe, and research is showing, that these signs serve a useful purpose. However, it is not fully known how well drivers perceive the effectiveness of these signs and act upon the information provided when they are displaying safety-related filler messages.

When there is no current traffic information to display, some researchers argue that the signs should remain blank while others say that safety and other public service messages should be displayed. A third alternative that some authorities follow is to display travel times; however, this option is feasible only when such information would be useful and the responsible agency can keep the information accurate (note that this alternative is followed for some VMS along the M1). Those researchers who believe that VMS should remain blank argue that if the signs display messages that drivers do not perceive as

useful, they will ignore future messages and risk missing critical information [4]. Further, messages such as public announcements may even annoy many drivers. As an example, Dudek [1] reported that the Los Angeles public reacted negatively when the following VMS messages were displayed along a freeway: 'Next time try Amtrak to Las Vegas' and 'Relieve congestion – rideshare' (p.15). Those researchers who argue that VMS should always display some type of message typically say that the signs are expensive so should be kept operating, and that if the signs remain blank, people may wonder if they are broken [1-2,9]. To counter this argument, some researchers recommend that VMS display 'a small number of pixels' to indicate that they are functioning but have nothing urgent to report [4].

This paper first reviews international research on VMS filler messages and then considers a framework for designing these messages. It is proposed that Michie, van Stralen, and West's [10] behaviour change wheel, discussed later, would provide a useful model for developing filler messages. It is important to research the use and effectiveness of VMS filler messages and to develop theory about them since many drivers are frequently exposed to them and they may be providing helpful learning, reminding, and other functions that may complement or enhance the structures already in place for encouraging safe driving. The paper concludes by describing several techniques of persuasion for writing short safety-related messages that attempt to change driver behaviour.

## Method

The research method consisted first of a literature review on international use of, attitudes towards, and effects of filler messages. Results from the literature were then compared to message displays as presented in the QGTMR manual [5] (see Appendix 1). Following this research, the paper argues that a model for designing better health care delivery and practice – the behaviour change wheel [10] – could be applied to the design of VMS safe-driving messages. Some specific techniques and examples for writing VMS safety messages are presented.

## Literature Review

This section reviews the results of seven papers organised in publication date order that in whole or part studied the use of VMS filler messages.

### Driver attitudes towards filler messages [6]

In focus group studies of 125 drivers and a follow-up telephone survey of more than 500 drivers in the Washington DC area, Benson [6] found markedly mixed reactions to VMS safety messages. From the focus groups, he reported that 'most participants agreed that VMS should include only traffic and road condition information' with one participant even saying that such signs should be treated as 'holy' (p.55). In contrast, Benson's telephone survey found that 67% (n = 337) of the

**Table 1. Results of Benson's [6] survey questions regarding drivers' attitudes towards safety messages on VMS (p.50)**

| Is it a good idea to post road-safety-related messages on VMS? | Yes            | No        |           |
|--|----------------|-----------|-----------|
|  | 337 (67%)      | 165 (33%) |           |
| Attitudes toward alternative use of VMS ( <i>n</i> , %)        |                |           |           |
|  | Excellent idea | Good idea | Poor idea |
| 'Drive to survive'   | 49 (10%)       | 248 (48%) | 216 (42%) |
| 'Lights on in bad weather'                                     | 181 (35%)      | 263 (51%) | 70 (14%)  |
| 'Tailgating is deadly'   | 171 (33%)      | 214 (42%) | 127 (25%) |
| 'Signal before changing lanes'                                 | 219 (43%)      | 199 (39%) | 94 (18%)  |

participants supported the use of safety messages (see Table 1). However, these participants showed more enthusiasm towards very specific messages such as 'Signal before changing lanes' than general messages such as 'Drive to survive'.

#### Focus groups with Brisbane and Sydney drivers [2]

Pedic and Ezrakhovich [2] conducted five focus groups with Brisbane drivers and three with Sydney drivers about VMS road safety messages. Participants were found to be strongly supportive of using VMS for this purpose. Regarding message design, participants thought that messages should be displayed on a single frame and be 'concise and direct' (p.9). The research also found that drivers would be more likely to read safety messages on these signs if traffic-related messages were accurate and updated regularly.

#### Small survey of US transportation professionals [11]

In another study, Jones and Thompson [11] working in Alabama, sent a limited email survey to 87 transportation professionals to determine how VMS in their localities were used during normal traffic. They received eleven responses (see Table 2).

**Table 2. Results of survey to transportation professionals (11 responses from 87 surveys [11] p.5)**

| Survey question  | Yes | No  |
|--|-----|-----|
| Should dynamic message signs display messages other than essential traffic control messages?                           | 43% | 57% |
| Would it be beneficial to drivers to display (non traffic-related) public safety messages?                             | 50% | 50% |
| Will displaying messages other than essential traffic control messages distract drivers?                               | 35% | 64% |
| Would displaying messages other than essential traffic control messages compromise traffic management objectives?      | 75% | 25% |
| Would displaying messages other than essential traffic control messages cause drivers to ignore dynamic message signs? | 85% | 15% |

Results of this survey indicate that most of the respondents (75%) believed that the display of filler messages on VMS would cause drivers to ignore these signs thereby reducing their effectiveness as traffic management devices. Nonetheless, the researchers [11] found that most of the surveyed agencies (61%) still used filler messages, and concluded that 'motorists are generally amenable to general messages on DMS providing they are carefully worded and informative' (p.10). Jones and Thompson recommended that drivers be educated about the different types of messages and how they contribute to improving the traffic system but did not state how this education should occur.

#### Use of filler messages in Bristol UK to encourage use of public transportation and decrease pollution [12]

Other research relevant to this study is the work of Chatterjee and McDonald [12] who studied the effectiveness of VMS in European cities. A part of this research focussed on driver responses to VMS in Bristol, UK, which displayed air quality information and messages to encourage drivers to travel by public transport. Typical messages said 'Air pollution high – use P + ride' or 'To city centre P + R 15 min car 24 min' (p.562). According to the study, while the pollution message was ineffective, '47% of survey respondents said that comparative travel times were effective in encouraging use of the Park and Ride system' (p.571). However, actual change that occurred as a result of these signs was small. Respondents (*n* = 852) said that after they saw the comparative travel times, they used Park and Ride for four percent of their trips. These results indicate that general public service announcements are ineffective and that the participants themselves may have overestimated the signs' effectiveness. According to the researchers, for public service messages on VMS to be truly effective, they need to be supplemented with other communication.

#### Focus group and survey of perceptions of VMS in Canada [7]

Tay and de Barros [7] studied perceptions of VMS in Canada by first holding a focus group and then conducting a survey with two participant groups. Although the focus group and survey concerned traffic-related and filler messages, this review considers only the information relevant to filler messages.

The focus group consisted of 16 transportation engineers and road safety experts. When asked what messages they could remember, all participants mentioned those about anti-drinking, the weather, seatbelt use, and driving courtesy. Thus, the participants had looked at the messages at least some of the time. The participants said, however, that the messages were repetitive and therefore something that they tended to ignore. As noted by the researchers, the VMS had become part of the driving background for these drivers. Participants thought that the messages should be designed and displayed to maintain interest. Some participants thought that the signs were too 'soft' and should be more 'hard-hitting' and current, providing examples such as 'xx people were killed this year' and 'xx % of the drivers today are speeding' (p.99). Some participants suggested that VMS should provide more personal messages to particular drivers about their current speed or how closely they were following. Most of the participants said that 'direct and immediate warnings' were more effective than 'soft-soft' messages in attracting attention. One participant thought that VMS should display only traffic-related information because other information reduced driver attention to them, but the other participants disagreed and thought they should be used for safety and driving behaviour messages.

For safety messages, most participants thought that emotionally-charged messages would be more effective than pure information in changing driver behaviour. However, a few participants thought that if a message was too emotional, it could have a negative effect. While most participants thought that both negatively and positively-charged messages could be effective, they thought that the greater effectiveness would come from negatively-charged messages, which stress the consequences of unsafe driving.

Following the focus group, the researchers ran a survey on two groups of participants, the results of which were combined. The first group had 94 participants consisting mostly of transportation engineering students but also friends and associates of the researchers. The second group had 613 participants who were drivers that had stopped at a popular highway petrol stop. The survey asked participants whether they remembered seeing any VMS messages along the highway and then provided them with a checklist upon which to note the types of messages seen. Many (82.5%) recalled seeing the messages, while 65% remembered the safety messages, 41% the weather information, 39% traffic-related information, and 13% other information.

The survey also asked drivers whether they thought it useful to display information about the 'weather, real-time traffic information, reminders not to drive too closely, general safety messages and reminders to be courteous on the roads' (p.104). Drivers agreed that such messages should be presented. The survey then asked drivers what they thought about specific messages. Most (89%) thought that VMS should display weather information; 71% thought that VMS should display reminders about following distance, but 22.3% were neutral and

6.6% were negative about them; 71.1% thought that VMS should display driving courtesy reminders, but 19.9% were neutral and 9% were negative about them; 72.4% thought that VMS should display general safety messages but 18.3% were neutral and 9.4% were negative about them; and 55.2% thought that VMS should display anti-speeding messages but 29.6% were neutral and 15.5% were negative about them. Thus, there was generally a positive attitude towards these messages.

Finally, the survey asked participants specifically about how they thought that two particular road safety messages affected them. They asked participants to state their level of agreement with the messages 'Reminders not to tailgate induce me to check my following distance' and 'Anti-speeding messages on message boards reduce my likelihood of speeding' (p.106). Regarding the tailgating messages, 51% agreed, 31.9% were neutral, and 17.1% disagreed. Regarding the anti-speeding messages, 32.7% agreed, 34.6% were neutral, and 32.6% disagreed. The researchers concluded that VMS safety messages should not be expected to change every driver's behaviour but should help a small share. Further, it may be that messages about some topics (e.g. weather conditions) are more effective than others (e.g. anti-speeding). The researchers also thought that road safety messages should be developed using theories and models of behaviour change and persuasive communication.

#### Survey of filler message use by US traffic agencies [1]

In the most comprehensive study to date of filler messages, Dudek [1] sent an online survey to managers or supervisors of US transportation agencies (state Department of Transportation and toll road agencies) to determine which types of messages they displayed instead of leaving VMS blank and how the public had responded to these messages. The survey presented participants with a range of VMS messages related to both more immediate road issues (e.g. crashes, roadwork) and filler messages, then asked which messages they currently displayed. The survey also asked for each agency's policies, guidelines, and practices for displaying filler messages, how these messages were categorised and prioritised, specific content of these messages, experiences and 'lessons learned' about the messages including public reactions, and any results from research that the agencies were conducting about filler messages (p.6).

The survey found that the choice to display non-traffic related messages was based typically not on the results of research, but on the preferences of management. Dudek reported that

Very little, if any, objective data from focus groups or other research studies were used in the decision-making process for displaying the messages. A significant percentage of (Traffic Management Centers) TMCs that display these types of messages did not know the public's attitude about the messages. (p.2)

Dudek classified the US filler messages as being about speed, safety campaigns, public service announcements (PSA), or traffic law or ordinance. Table 2 presents examples of these messages.



**Table 2. Examples of US filler messages [1]**

| Message type                       | Message purpose  | Examples   |
|------------------------------------|--|--|
| Safety campaign                    | In the USA, such messages repeat or deliver part of a state's driver safety campaign | Buckle up for safety<br>It's the law                     |
|                                    |  | Drive hammered<br>Get nailed                             |
|                                    |  | Work zone safety week                                    |
| Public service announcements (PSA) | Non-traffic related messages about general public concerns                           | Report DWI (driving while intoxicated)<br>1-877-DWI-HALT |
|                                    |  | Blood drive<br>Hinsdale Oasis                            |
|                                    |  | Van and carpool<br>Call 1-800-555-5555                   |
|                                    |  | Air quality alert<br>Today<br>Tune to 530 AM             |
|                                    |  | Burn ban<br>In effect for<br>Nueces Cty                  |
| Traffic law or                     | Reminders of laws or penalties for violating laws ordinance                          | Georgia law<br>Headlights on<br>When raining             |
|                                    |  | Slow down or<br>Move over for<br>Emergency vehs          |
| Speed                              | Reiterate the legal limit  | Speed limit 55<br>Drive safely                           |
|                                    | Provide advice about speed   | Dense fog<br>Advise 30 mph                               |

One hundred agencies responded to the survey. They were asked specifically which types of filler messages they used and then to give the public's reason to the messages on a scale from very favourable to very unfavourable. Results showed that the most commonly displayed type of filler message in the US was the safety campaign message, which was displayed by 83% of the reporting agencies [1]. This type of message is also displayed in Queensland, as for example in the message 'RBT (random breath testing) Anytime, Anywhere'. Driver reactions to safety campaign messages as reported by the US agencies

were 29% (n=24) in the favourable range, 18% (n=15) neutral, and 2% (n=2) unfavourable. Of note, about half (51% or n=42) of the agencies that displayed safety campaign messages had no information regarding drivers' reaction to them. In the US, such messages are typically part of states' safety campaigns, and according to regulations, 'should be current, displayed for a limited time, and should relate to a specific safety campaign' (p.33).

The next most commonly-used filler message as reported by US agencies was the Public Service Announcement (PSA). In Dudek's study [1], 30% of agencies reported that they displayed PSAs. Driver reactions to PSAs as reported by the US agencies were 27% (n=8) in the favourable range, 27% (n=8) neutral and 3% (n=1) unfavourable. Of note, 43% (n=13) of the agencies that displayed these messages had no information regarding the public's response to the signs. PSAs are also displayed occasionally on Queensland VMS (e.g. 'Blood stocks low. Call xxxxxx to donate').

The third most commonly-used filler message as reported in this study was the traffic law or ordinance message, which was displayed by 26% of the agencies. Public reaction to these messages was more positive than that for safety campaigns and PSAs. Driver reactions to traffic law messages as reported by the US agencies were 31% (n=8) in the favourable range, and 38% (n=10) neutral. Thirty-one percent (n=8) of agencies had no information on which to gauge public reaction to these messages. These messages, too, are displayed along the M1 (e.g. 'Texting + driving = \$300 + 3 points'). Finally, speed messages were the least commonly displayed by agencies with only 15% of agencies using them. Three agencies (20%) reported public reactions to these messages between favourable and neutral, and 80% (n=12) of these agencies had no information regarding the public's reaction to the messages.

Looking at public response to all of the messages considered by Dudek [2], reactions were generally more favourable than unfavourable, but many people reported a neutral reaction and many agencies did not know what drivers thought about the messages or whether the messages were having any impact on drivers. These results indicate the need for further research on the public's reaction to filler messages.

#### Survey and on-road experiment of two VMS anti-speeding messages in Alberta, Canada [13]

Another study by Tay and de Barros [13] aimed to evaluate the effectiveness of the two VMS anti-speeding messages 'Speeding will catch up to you' and 'Don't save time, save lives'.

According to the researchers, the first message focussed on 'the legal threat of speeding' while the second focussed on the 'physical threat' (p.19). The study began with a questionnaire that asked participants to rank their level of agreement with a series of statements about each message, one of which was: 'The message increases my likelihood of obeying the speed limits'. For the legally-threatening message, 2.1% of the 97 respondents strongly agreed and 22.3% agreed. For the

physically-threatening message, 1.1% strongly agreed, and 27.7% agreed. These results indicate that some drivers see a benefit in displaying VMS anti-speeding messages, and that for these drivers, the physically-threatening messages were seen as slightly more persuasive.

The next part of the study consisted of on-road tests of each message to determine and compare their effects. The researchers compared driver speeds at the site of a single VMS sign during periods in which no message was displayed and then when each of the test messages was displayed. Speeds were measured in both a fast and a slow lane. While the study found no noticeable decrease in the mean traffic speed for the legally-threatening message, it did find a noticeable decrease in the standard deviation of driver speeds (from 7.9 to 7.2 km/h in the fast lane and from 9.2 to 8.7 km/h in the slow lane) and a slight reduction in the percentage of drivers travelling at higher speeds. The standard deviation of driver speeds is a measure of the variance among speeds, and a decrease in it and the top end speed are thought to aid in reducing potential crashes. Thus, the legally-threatening message had minimal positive effects on driver speeds.

For the physically-threatening message, the mean speed decreased slightly (from 119.7 to 118 km/h in the fast lane and from 111.1 to 109.6 km/h in the slow lane), the percentage of drivers who were travelling above the speed limit decreased substantially (90.7% to 86%; 55.0% to 50.0%), but the standard deviation increased slightly (7.7 to 9.3 km/h; 8.9 to 10.1 km/h). There was a mixed result between the percentage of drivers who were travelling 15 km/h over the limit in the fast and slow lanes; in the fast lane, the percentage of drivers speeding increased from 9.8% to 15.9%, but in the slow lane, decreased from 3.9% to 3.3%.

In this study, although both of the tested anti-speeding messages had small but helpful effects on travel speeds, the physically-threatening message had a slightly stronger effect than the legally-threatening message. The fact that a high percentage of drivers were travelling above the speed limit in both the fast and slow lanes throughout the study could mean that the observed drivers believed that they would not be legally punished for speeding or that the punishments were not severe enough deterrents (the percentage of drivers travelling over the limit ranged from between 86% - 90.7% in the fast lanes and between 50.0% - 55% in the slow lanes). Perhaps the physically-threatening message was more effective because this possibility for punishment seemed more possible.

#### Literature review summary

It is now useful to summarise the reviewed research. First, not all and perhaps only some drivers will find safety or other filler messages (or for that matter any VMS messages) to be useful [6,7,13]. This finding is reasonable since research shows that individuals do not and cannot actively attend to every road sign [14]. Even when seemingly more important information is displayed such as a recommendation for drivers to divert because of a crash, it cannot be guaranteed that all drivers will

attend to the information [12]. Having started this summary with the idea that not all drivers will find filler messages useful, the reviewed research nonetheless indicates that drivers generally would prefer to use VMS for displaying safety messages than to leave them blank [2,6-7,11]. Further, the reviewed research shows that if filler messages are to be displayed, drivers would generally prefer to see more specific than general messages [6-7]. In addition, emotionally-charged messages, particularly those emphasising the negative consequences of unsafe behaviour, are seen as being more effective in encouraging safe driving [7]. The research also provided evidence that some filler messages are having positive effects on driving safety [13].

Regarding specific filler messages, the Chatterjee and McDonald study [12] showed that general public service announcements on VMS are ineffective. Thus, more research is needed on how VMS filler messages could be used as part of larger public service campaigns. Further, the Dudek study [1] reported that drivers responded somewhat more favourably to traffic law or ordinance messages than to safety campaign, public service, or speed-related messages. This result can be considered in light of the studies conducted on static road signs [15-16]. These studies compared driver recall of general warning and crosswalk signs to more specific signs (e.g. speed limit change and police control area) and found that drivers better remembered the latter. The researchers theorised that drivers pay more attention to personally threatening than general messages. Tay and de Barros's [13] research in Canada examined drivers' perceptions and on-road behaviour towards two personally threatening anti-speeding signs. One threat was from the law and the other concerned physical safety. In this study, the physically-threatening message had slightly more effect on drivers' speeds. The paper now considers what might be a useful set of principles for designing filler messages.

### Using the behaviour change wheel as a framework for designing VMS filler messages

For road signage in general, design follows the principle of *positive guidance*, which Russell [17] defined as 'the concept that a driver can be given sufficient information where he/she needs it and in a form he/she can best use... to safely avoid a hazard' (p.155).

In contrast to other road signage, VMS filler messages do not follow this principle yet like other signage certainly need specific frameworks on which to be designed. It is proposed here that a useful way to consider the function of VMS filler messages is as *behaviour change interventions for safe driving*. Further, a useful tool for considering a full range of such interventions is Michie, van Stralen, and West's [10] *behaviour change wheel* (Figure 2), which was developed for the purpose of encouraging healthy lifestyles and delivering more effective health care, but is of course also useful for designing and selecting behavioural interventions in many other contexts. The tool was designed for

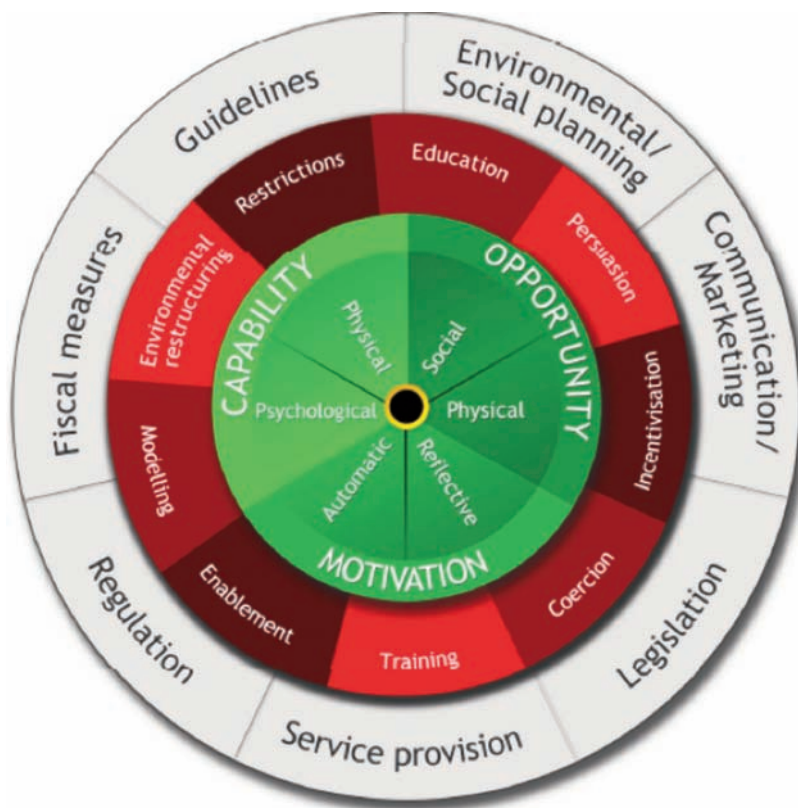


Figure 2. The behaviour change wheel [10] ( p.1)

policy makers and practitioners. Tay and de Barros [13] have also noted that VMS safety messages should be designed using theories of behaviour change and persuasive communication. They suggested that designers of these messages apply theories and models such as ‘the health belief model, protection motivation model, extended parallel process model, elaboration likelihood model, social cognition theory or theory of planned behaviour’ (p.107). All of these theories and models fit within the structure of the behaviour change wheel and should certainly be considered in safety message design.

Michie, van Stralen and West [10] define behaviour change interventions as ‘coordinated sets of activities designed to change specified behaviour patterns’ (p.1). In developing the behaviour change wheel, they argued that to improve the likelihood of an individual adopting a prescribed behavioural change (an intervention), the person responsible for prescribing the change needs to have a method for characterising the various types of interventions (e.g. education, training, or coercion) and knowledge of how to link the interventions to the desired behaviour. To develop the wheel, the researchers reviewed nineteen behavioural change frameworks and seven categories of health care delivery policy, but found that none of the existing descriptions was comprehensive enough and that few demonstrated how they linked to a model of human behaviour. The researchers argued that the behaviour change wheel fills the gap found in their research. This paper will now describe the wheel and then focus on those parts of it that are applicable to designing VMS filler messages.

As shown in Figure 2, the central portion of the wheel provides a model of a person’s willing behaviour, which is based upon that person’s skills or *capability* to perform the behaviour, reason or *motivation* to perform the behaviour (which could include a habit), and environment or *opportunity* in which to perform the behaviour. Michie, van Stralen and West [10] define capability, motivation, and opportunity as follows:

- **Capability** is the individual’s psychological and physical capacity to engage in the activity concerned. It includes having the necessary knowledge and skills.
- **Motivation** is all those brain processes that energise and direct behaviour, not just goals and conscious decision-making. It includes habitual processes, emotional responding, as well as analytical decision-making.
- **Opportunity** is all the factors that lie outside the individual that make the behaviour possible or prompt it. (p.4)

The middle ring lists nine categories of interventions that may influence different aspects of a person’s behaviour. As shown in Figure 2, these categories are education, persuasion, enablement, training, incentivisation, coercion, restriction, modelling, and environmental restructuring. Because VMS messages are written communication, it is technically possible to directly use them only for the first three listed interventions of education, persuasion, and enablement. However, as shown in Table 3, VMS can be used to deliver messages about the other interventions. For example, while VMS cannot in and of

**Table 3. Behaviour change interventions as listed and defined [10] (p.7) and with examples for VMS messages**

| Intervention                | Definition  | Example applications in VMS messages  |
|-----------------------------|---|---|
| Education                   | 'Increasing knowledge or understanding'   | Teach people about safe driving practices, road rules and vehicle care  |
| Persuasion                  | 'Using communication to induce positive or negative feelings or stimulate action'   | Encourage people to imagine outcomes from positive driving behaviour or effective vehicle care, or any negative outcomes that could result from unsafe behaviours |
| Enablement                  | 'Increasing means/reducing barriers to increase capability or opportunity'  | Remind drivers to perform particular behaviours (e.g. during wet weather, display a message such as <i>Drive to the conditions</i> )                              |
| Training                    | 'Imparting skills'  | Provide information about advanced driver training programs   |
| Incentivisation             | 'Creating expectation of reward'  | Establish government rewards for safe driving (e.g. reduced car registration fees for vehicle owners having no driving violations) and display the rewards on VMS |
| Coercion                    | 'Creating expectation of punishment or cost'  | Display punishments for violating various driving rules   |
| Restriction                 | 'Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours)' | Display various driving rules   |
| Modelling                   | 'Providing an example for people to aspire to or imitate'   | Ask parents to behave as safe driving role models for their children (see [18]). Such messages could become part of a larger educational campaign.                |
| Environmental restructuring | 'Changing the physical or social context'   | VMS signs themselves are a form of environmental restructuring  |

themselves deliver skills training, they can provide information about where to get training in driving skills.

On the outer ring of the behaviour change wheel are policy areas for encouraging change. The listed areas consist of creating new communication or marketing programs, government or professional guidelines, fiscal arrangements, regulations, legislation, environmental or social plans, and providing services. No discussion will be given here about policy change.

To use the wheel to design VMS filler messages, a designer would begin with a description of the behaviour desired from a target audience (e.g. all drivers should indicate before changing lanes) and then generate potential messages using the list of interventions. It is recommended that after generating such a list, the designer of course tests the messages with target audience members. The categorisation of road safety messages in the QGTMR manual [5] actually already follows this approach but could be more detailed. Road safety messages are categorised as follows:

- speed
- fatigue
- following distance
- vehicle maintenance
- excessive lane changing (p.12).

Other message categories that could also be listed include health and driving, distraction, road rules and violations, and motorcycle driving. To provide more detailed message categories, designers could list, for example, all of the types of vehicle maintenance that drivers should do to avoid crashes and then generate different types of intervention messages using those listed in the wheel. Advantages of using the behaviour change wheel to design messages are first that it helps designers to avoid neglecting potential options, and second that it encourages creativity by helping designers identify a range of approaches.

### Techniques for writing persuasive VMS safe driving messages

This paper now reviews some possible techniques for writing persuasive VMS safety messages. The discussion is not meant to be exhaustive as the science of persuasion is incomplete. Other techniques than described here may be available to serve as structures for developing messages. The techniques described are not directly described by the behaviour change wheel since it is a larger framework, but rather are subsumed by ideas within it. The first technique described is the *assertion message*, which is commonly used by psychologists and communication specialists during attempts to change behaviour (for examples



see [19]). Other described techniques are taken from Thaler and Sunstein's book *Nudge: Improving decisions about health, wealth, and happiness* [20], which summarises current research on psychological biases and effects of different message types on decision making, and was recommended by the designers of the behaviour change wheel [10]. Ideas from this source that are discussed here are the construction of messages to encourage people to *actively think about their personal behaviour and its ramifications*, the design of messages to encourage behaviour change based on people's aversion to loss, and a consideration of the timing of certain messages based upon people's *availability bias*.

First, messages can follow the format of assertion messages, which both explicitly describe a desired behaviour and explain why it should be followed [19]. An example of a VMS safety message that is written in this format is 'Tailgating causes crashes. Follow at a safe distance'. Returning to previously reviewed research on VMS safety messages [6], people tended to prefer specific messages such as provided above to more general ones.

One technique of persuasion is to evoke people's imagination, for example to try to get people to actively think about their personal behaviour and its ramifications. Asking a question is a way to encourage thinking as in the current Queensland VMS messages 'Following too closely? Back off for safety' and 'Checked your tyres lately?'

Messages can also take advantage of people's *loss aversion* or fear of losing something [20]. Threatening messages use this principle such as 'Texting + driving = \$300 + 3 points' or 'RBT [random breath testing]. Anytime Anywhere'. Returning to previously reviewed research on driver attention to signs [15-16], drivers paid more attention to personally threatening messages such as in the example provided than to general ones.

A psychological bias to consider when writing messages is the *availability bias*, which is a person's ability to bring something to mind [20]. When someone has had recent and frequent exposure to an idea (e.g. advertising about McDonald's fast food), that idea will tend to be recalled first or near the top of the person's list of ideas when he or she is asked a question related to it (e.g. 'Where should we go for lunch?'). In regard to VMS, messages related to safety campaigns should be most effective during or shortly after the campaign, and therefore older messages should be deleted from VMS message banks.

## Conclusions

This paper has reviewed research on the use of safe driving filler messages on VMS. Examples were taken from the Queensland manual for VMS [5]. Although there is controversy regarding the use of VMS to deliver safety messages, results indicate that more drivers would prefer to have these messages than not, that drivers prefer signs with more specific behavioural change messages, and that some of these messages are having positive effects on at least a small share of drivers. It is suggested that

the behaviour change wheel developed by Michie, van Stralen and West [10] be adopted for developing messages, and that specific techniques of persuasion be tested to see how drivers perceive them and how effective they would be on-road. It is important to conduct further research on VMS safety messages.

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**Appendix 1. General Road Safety Filler Messages [3] (p.29)**

| Screen 1 |                       |                       | Screen 2           |               |                    |
|----------|-----------------------|-----------------------|--------------------|---------------|--------------------|
| Line 1   | Line 2                | Line 3                | Line 1             | Line 2        | Line 3             |
| 1        | Breaking              | Road rules            |                    |               | Causes crashes     |
| 2        | Buckle Up             | Be here               |                    |               | Here for Life      |
| 3        | Changing Lanes?       | Always indicate       |                    |               |                    |
| 4        | Checked your          | Tyres lately?         |                    |               |                    |
| 5        | Distracted drivers    | Are dangerous         |                    |               |                    |
| 6        | Driver fatigue        | Wake up               |                    |               | To the signs       |
| 7        | Drive Sober           | Be here               |                    |               | Here for Life      |
| 8        | Drive Safely          | Be here               |                    |               | Here for Life      |
| 9        | Following             | Too closely?          | Back off           | For safety    |                    |
| 10       | Give trucks           | More space            |                    |               |                    |
| 11       | Indicate              | Lane Changes          | Be here            | Here for Life |                    |
| 12*      | Keep left             | Unless overtaking     |                    |               |                    |
| 13*      | Keep left             | Unless overtaking     |                    |               | Share the road     |
| 14       | Merge safely          | Choose a safe gap     |                    |               |                    |
| 15       | Motorcyclists         | Be aware              |                    |               | Take care. Survive |
| 16       | On medication?        | Check it's safe       |                    |               | To drive           |
| 17       | Speeding?             | Slow down             | Be here            | Here for Life |                    |
| 18       | Speeding when         | Overtaking is illegal |                    |               | Slow down          |
| 19       | Tailgating            | Causes crashes        | Back off – Be here | Here for Life |                    |
| 20       | Tailgating            | Causes crashes        | Don't follow       | Too closely   |                    |
| 21       | Tailgating            | Causes crashes        | Follow at a        | Safe distance |                    |
| 22       | Texting + driving     | = \$300 + 3 points    |                    |               |                    |
| 23       | Health problems?      | Safe to drive?        |                    |               |                    |
| 24       | Always drive          | To the                |                    |               | conditions         |
| 25**     | Variable speed limits | Are enforced          |                    |               |                    |
| 26***    | Traffic info          | Phone 131940          |                    |               |                    |
| 27***    | Traffic info          | 131940.qld.gov.au     |                    |               |                    |
| 28       | Towing?               | Take care next XXkm   |                    |               |                    |

\* Messages for use in speed zones greater than 80km/h      \*\* Messages for use in variable speed limit zones only.

\*\*\* Messages only for use in regions where 131940 service is active.

**Editor's note:** In the last issue of the journal (Vol 22 No. 3 - the special issue on heavy vehicle safety), references were inadvertently omitted from the peer-reviewed article *Investigating the role of fatigue, sleep and sleep disorders in*

*commercial vehicle crashes: A systematic review* by LN Sharwood et al. The editor apologises for this omission. The complete article, with reference list, can be viewed on the College website: [www.acrs.org.au/publications/journalscurrent](http://www.acrs.org.au/publications/journalscurrent).