Want to speak? Envisioning driver-to-driver communication for emotion regulation

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Abstract Poor communication between car drivers elicits negative emotion while driving. In this study, we envisioned rich communication between drivers to alleviate their negative emotions. An empirical study was conducted based on the conceptual design prototype for emoticon-based communication between car drivers. We found key findings and insights for enriching driver-to-driver communication for emotion regulation. The results were categorized into three aspects: driver-to-driver communication as rich communication, social communication and computer-mediated communication.

Keywords *Driver interaction, Emotion regulation, Interpersonal communication, User experience*

Introduction

The term "aggressive drivers" was identified for the first time by Tillman and Hobbs (Tillman & Hobbs, 1949). Even though it was almost 70 years ago, aggressive driving ("road rage") is still a current social issue. Several studies have shown the relationship between the negative emotion of car drivers and its impact for poor driving performance. Bañuls and Montoro (Bañuls & Montoro, 2001) mentioned that drivers who are confused have a high possibility of breaking traffic rules, which can lead to accidents. Hudlicka and McNeese (Hudlicka & Mcneese, 2002) found that nervousness of drivers can cause them to focus on specific sights too much or make biased judgments. Various studies including Wells-Parker et al. (Wells-Parker et al., 2002) have reported that anger of drivers can increase the car crash rate. For these reasons, it is important to solve the emotional problems of drivers.

There were several approaches to focusing on the emotion of drivers. Jonsson et al. (Jonsson et al., 2004) explored the effect of blaming drivers with recorded voice on their attitudes. Nass et al. (Nass et al., 2005) examined the impact of matching the car voice emotion and the driver emotion. Harris and Nass (Harris & Nass, 2011) proposed the auditory interface to regulate the emotion of drivers with the psychological background. Although much work has been done, it is necessary to define which emotional situation or context while driving is important.

Driving on the road is a social activity wherein drivers continually influence each other. One of the important factors that cause drivers to develop negative emotions is poor communication with other drivers (Shinar, 1998). Current communication channels while driving such as horn, turn signals and high beam are restricted modalities because of the cognitive workload and visual distraction of drivers. Due to these safety issues, drivers only can communicate with a limited amount of information.

However, after 100 years of history in the automobile industry, cars are now changing from mechanical products to electronic products, with the development of ubiquitous computing, internet-of-things (IOT) services and vehicle-to-vehicle (V2V) technology. With these technological backgrounds, drivers can be allowed to exchange the amount of information with other drivers. Moreover, automation issues such as driver assistance systems may solve current restriction of communication modalities.

Recent studies explored the possibility of driver-to-driver communication. Schroeter et al. (Schroeter et al., 2012) mentioned the concept scenarios of the vehicle as a social platform. Wang et al. (Wang et al., 2014) suggested scenarios for driver-to-driver communication on the highway made by a design workshop. Lamas et al. (Lamas et al., 2014) conducted scenario-based study with 24 participants and found requirements and design issues for driver-to-driver communication. Liu et al. (Liu et al., 2015) examined the effect of expressing emotion while driving with emoticons and simple text. Although much work has been done, in-situ studies need to be conducted to explore the possibility of a new way of communication between drivers, especially focusing on emotion regulation.

In the study, we designed the conceptual design prototype for emoticon-based communication between car drivers and found its value via an empirical study. The purpose of the study is to a conduct qualitative in-the-wild user study to observe and analyze user experience in driver-to-driver communication context. The first contribution of the study is to explore what considerations or factors are important to design driver-to-driver communication for emotion regulation. The second contribution is to provide a new design opportunity for interaction designers and

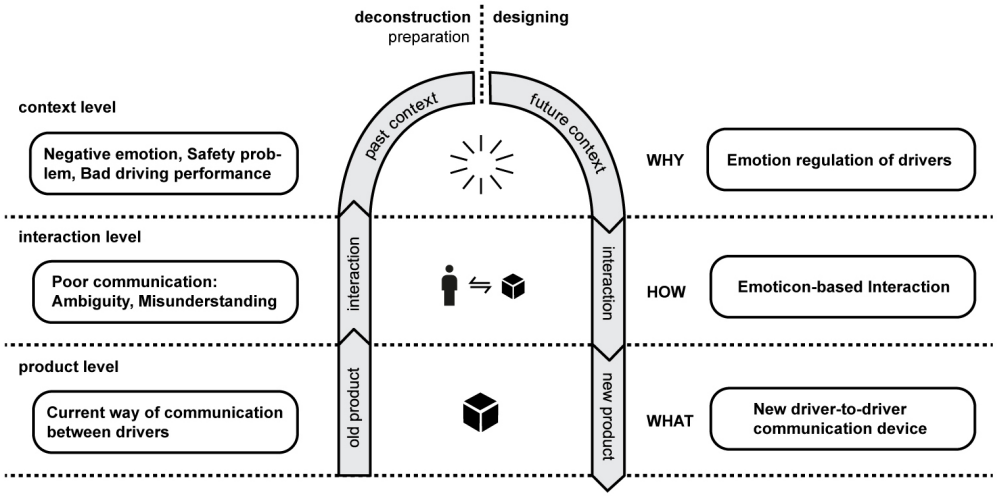

Figure 1. Vision in Product Design (ViP) model and envisioning driver-to-driver communication for emotion regulation.

researchers to help them envision driver-to-driver communication for emotion regulation in the near future.

Envisioning driver-to-driver communication for emotion regulation

The process of the study follows the Vision in Product Design (ViP) model by Hekkert and Van Dijk (Hekkert & Van Dijk, 2001) to systematize our approach to driver-to-driver communication for emotion regulation (Figure 1). As we mentioned in the introduction part, we started the old product (WHAT): the current communication modality or device between drivers. The problem is mainly focused on interaction level (HOW): poor communication can result from ambiguity or possibility of misunderstanding. This problem is an important issue in the driving context because it can have a negative impact on the emotion of drivers and their safety (WHY). The study envisions the future context wherein the drivers can alleviate their negative emotions that are occurring because of communication between drivers (WHY). We conducted the study through the design artifact, which was designed for emoticon-based communication (HOW) and explored the experience of drivers. These steps might assist in designing a new communication system between drivers that will help regulate their emotions (WHAT).

System design

We suggest the system design of driver-to-driver communication for emotion regulation based on the communication model of Shannon (Shannon, 2001) (Figure 2). It consists of five features: Speaker (Source), Encoder, Channel, Decoder, and Listener (Receiver). The driver who wants to speak (Speaker) sends the message to other drivers. Encoding and decoding is assisted by the Channel, such as wireless V2V technology. Then, the other driver (Listener) receives the message. We thought this process could prompt two changes for drivers: affective change and behavioral change. Speaker may reduce the negative emotion by speaking some emotion aloud or giving other information to the Listener. The Listener may

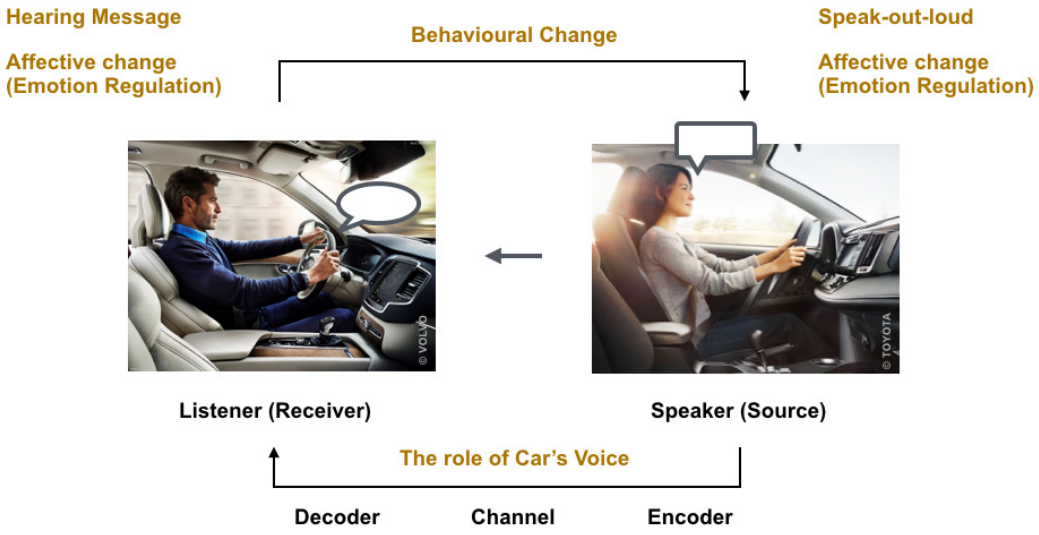

Figure 2. System design of driver-to-driver communication for emotion regulation.

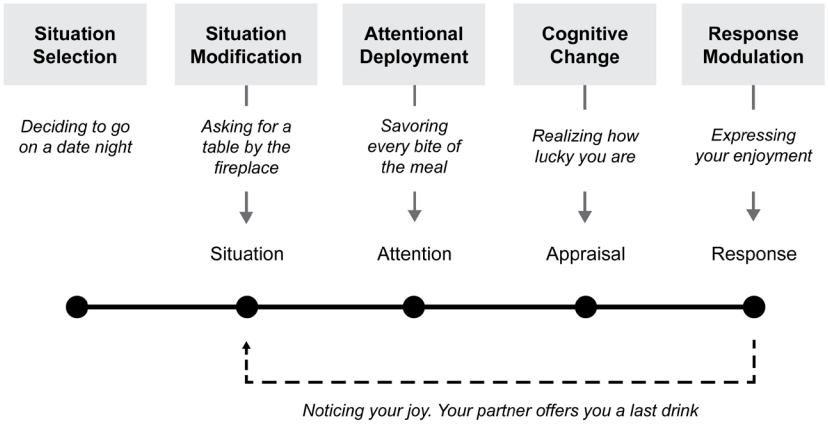

Figure 3. The process model of emotion regulation. Examples were from Quoidbach et al. (Quoidbach et al., 2015).

reduce the negative emotion by listening to some words from the Speaker. Behavioral change can be performed by both drivers while certain events occur on the road. Based on the rich communication, we expect that the Speaker and Listener can control their emotions through the communication and can change their driving behavior in a positive way.

In this study, we started from these questions: If we let drivers use the design artifact that enables drivers to do rich communication with other drivers, what kinds of emotion or information will the drivers want to speak (listen) and why? What kinds of context will they want to speak (listen)? What is the relationship between their communicating behavior and their emotion?

Emotion regulation

The process model of emotion regulation is based on the Gross's work (Gross, 1998). The model suggests that emotions might be regulated at one of five points: 1) Selection of the situation, 2) Modification of the situation, 3) Deployment of attention, 4) Change of cognitions, and 5) Modulation of the response. We envision the system which can regulate the driver's emotion based on these five points. As a starting point, we implemented the prototype which is focused on the 4) Change of cognitions and 5) Modulation of the response. The prototype allows the emotional expressions to other drivers via emoticons and we hope the prototype may elicit the driver's cognitive change and the user's modulation of the response.

Method

Online survey

We conducted an online survey to obtain diverse opinions and objective data from drivers. The survey was carried out online to enhance respondent accessibility, and a survey supplied by Google Spreadsheets was used. A total of 75 cases were collected among 51 males and 24 females. We provided questions regarding 1) the level of stress felt when driving, 2) the need for communication between other drivers while driving, 3) which emotion is expressed most to other drivers when driving, 4) how to express information or emotions to other drivers.

The result of the online survey shows that Ninety-two percent of respondents (69 in total) felt stress during driving. Of all respondents, 84.3% (64 total) answered that they needed to communicate with other drives while they drove, which shows that most drivers need communication with other drivers. The most expressed emotions from driver to driver were appreciation (24 instances), anger (17 instances), regret/apology (16 instances), and surprise (9 instances). The reported means to convey information or emotions to other drivers were using the turn signal on both side (20 instances), using high beams (18 instance), honking the horn (16 instances), using hand signals (10 instances), using facial expressions (3 instances), using voice (2 instances), and holding down the head (2 instances).

Design artifact

Based on the survey results, we designed the prototype which allows the emotional expressions to other drivers via emoticons (Figure 3). A driver could express the four different emotions with the prototype: appreciation (happy), anger, apology (crying) and surprise. It was designed for use in a real driving context rather than a simulator.

The prototype consists of four main buttons that were installed on the center console (middle of the dashboard) and a red LED dot matrix on the rear window (Figure 4). When the driver presses a button, the emoticon is shown on an LED display, and the driver who follows can recognize it. We considered the usability of a driver who presses the button, considering distraction and safety issues. The color and the size of the emoticon also were considered carefully to clearly identify the emotional expression to the following driver. The prototype was implemented by Arduino to control the LED display output with input buttons.

Experimental design

Ten drivers participated in the study. The average age of the participants was 27 years old (ranging from 24 to 36, SD = 3.32). All participants had more than one year of driving experience, considering the safety issue of in-the-wild study. The participants drove a car that was rented from a car-sharing service, and the prototype was installed. Another participant drove in

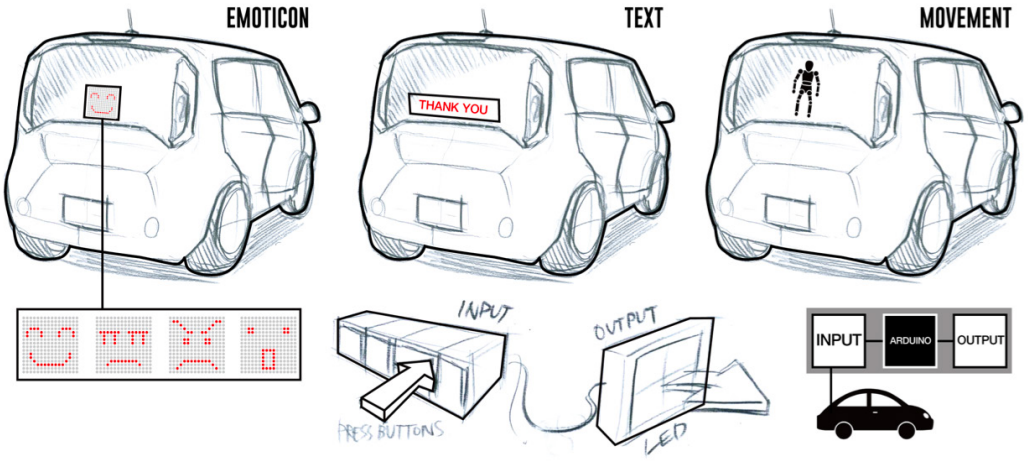

Figure 4. Design sketches for driver-to-driver communication.

Figure 5. Design artifact: emoticon buttons (left) and LED display on the rear window (right).

another car and followed the car in which prototype was installed. Every participant made a pair, and they took part in two different driving sessions to experience both 1) expressing emotion to the driver following behind and 2) understanding the emotion of the front driver. We also implemented a normal driving session (driving without prototype) to compare the driver's attention and attitude in both condition. Therefore, there were four different driving sessions in the experiment (Figure 5). To control the four different conditions, we fixed the driving route. The driving route was designed to take around 10 minutes, or a total of 40 minutes, for one participant. The route included narrow roads, high levels of pedestrian movement, and numerous traffic lights. We focused on what participants felt about the driving experience across the four different conditions. Due to safety issues, a researcher of the experiment sat next to the driver in every session, and we recorded 1) the behavior and speaking of the driver and 2) the front view while driving. The researcher asked the driver to speak out loud about interesting events related to other drivers, not only when the driver pushed the buttons. After the participants finished driving, the participants came back to the laboratory and were interviewed. In the interview, we asked for the participants' opinions about the driving experience, and the video that recorded the driving session was played during the interview so that participants could easily recall the situation.

Results & discussion

We analyzed and evaluated the data that we recorded during the driving sessions and the debriefing interview. There were several findings and insights to consider while assessing the design of the driver-to-driver communication system and its relation to emotion. We summarized and categorized the results into three different perspectives of communication.

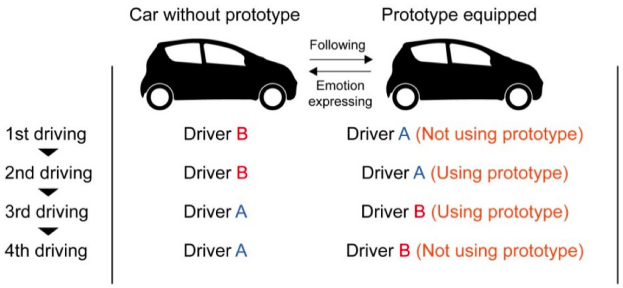

Figure 6. Experimental design: driving sessions.

Rich communication

According to the interview, most participants positively mentioned the richness of the communication between drivers. The comments were about the new value and possibility of the communication system. They mentioned that communication via emoticon was easy and fun. Moreover, they agreed that the device may elicit a positive atmosphere between drivers. The important insight about the richness of the communication is that participants have used the prototype for two objectives: 1) to deliver information related to driving context and 2) to express their own feeling and emotion directly to others.

Delivering rich information

Some of the participants used the prototype to deliver more information that they only could send through the prototype. It was an interesting finding because we designed the prototype to let the user to only convey their own emotion or feeling. In the case of P2, the participant delivered the driving situation cue through the emoticon. P7 tried to elicit the empathy of the driver rather than express an emotion itself.

"Traffic information also can be transmitted by emotional expression. For example, when the pedestrians block the narrow alley, I can show the 'crying' emoticon and let the driver behind know that I'm also stuck." (P2)

"When the car in front of me drives too slowly or the red [stop] light was too long, I pressed the crying button to elicit the empathy of the driver behind me." (P7)

Expressing & understanding feeling

Compared to the previous examples, the expression of emotion was also useful to alleviate participants' feelings such as anger. We found that the prototype enables drivers to express emotion as they tell a story to other people in terms of controlling their own emotion or making empathy.

"When I was angry, I expressed the anger with the 'anger' emoticon to the driver behind me rather than honking to the front. And the anger eased a little bit." (P2)

"By pressing the several emoticons, I delivered my feeling as if to tell the driver behind me." (P3)

Social communication

Social distance

The current communication system between drivers is based on anonymity and the physical shield among drivers (Ellison - Potter et al., 2001). If the rich driver-to-driver communication does not fully consider the social distance between drivers, it might have a negative impact on the driving experience. We found the possibility of the communication system maintaining the social distance in a gentle way and enabling the emotional empathy between the drivers at the same time. It is a valuable insight that the communication can move beyond the signal sending and receiving.

"… [When I saw the emoticon] I could have a good impression of the front driver. Then, I was thinking about why the driver presses that [emoticon] button, and I tried to feel empathy the driver." (P3)

"I pressed the crying button, and I expect that the driver behind me can alleviate [a] stuffy feeling. If all drivers can communicate like this, polite and considerate driving can be possible." (P7)

"When I see the smiling face [emoticon], I also smiled as if I was facing the other person who smiles." (P8)

Personality

We found that the driver's personality may affect the rich communication and that designers should consider the various kinds of drivers. This is an important finding because the strategy for emotion regulation also should be different depending on drivers. The system may help some drivers who are not familiar to express their emotion to other drivers, as P1 said.

"…When driving alone, I do not make much expression to other drivers, but these kinds of options might allow easier emotional expression, even if the driver is passive." (P1)

Computer-mediated communication

Current driver-to-driver communication has different characteristics from face-to-face communication, which is more verbal and has eye-contact. Renner and Johansson (Renner & Johansson, 2006) and Lamas et al. (Lamas et al., 2014) also mentioned the difference between driver-to-driver communication and face-to-face interaction. Moreover, we found that it is necessary to compare the characteristics of driver-to-driver communication with computer-mediated communication (CMC) (Walther, 1996). Computer-mediated communication such as text messaging and online chat has similar characteristics to rich driver-to-driver communication because some medium between users exists and should be designed precisely. To develop the rich communication between drivers, mediating drivers based on the characteristics of driver-to-driver communication is essential.

Modality

Several comments about modality or functional issue were collected. P3 recommended the voice or speech-based communication. However, there was concern about the modality because it can bother the driver while he or she is listening to other content, especially when a voiced navigation system is turned on. Not only the issue of social distance but also the sound or voice should be precisely intended and designed. Other functional details included the need for clear feedback when the driver sends the message to others (P6) or a function allowing a driver behind to send a message to a driver in front (P7).

Trust

Although we studied rich communication, a misunderstanding also can occur. In the experiment,

we found that emoticon is also ambiguous in complex driving context. If the rich communication is the same as a phone call or so-called "walkie-talkie," expression of anger or negative emotion can directly lead to danger. This suggests the importance of encoding and decoding process through the channel, which is a matter of how the designer designs the medium between drivers. If the expression of the drivers can be revised, reduced, or even exaggerated to elicit positive atmosphere between drivers, it might connect to the trust issue: trust between drivers, and trust between the driver and the car interface. How much of this should the designers control? What is the optimal system for driver-to-driver communication and emotion regulation as a new type of computer-mediated communication?

Limitation

The customs and etiquettes related to car driving are different in various cultures. However, our study was only conducted in South Korea. Cultural issues related to driver-to-driver communication should be further investigated across various cultures. Moreover, our study was an in-the-wild study, and the safety of the drivers was important. Thus, a researcher sat next to the participants in every observation, but this might have caused Hawthorne effect. We should try to find a better way to observe the driver when they are driving alone, because emotional expression and communication between drivers can be affected by the other passenger.

Conclusion

We studied how drivers can communicate with other drivers through a conceptual design artifact. The prototype enabled the participants to communicate rich information and convey emotion via emoticon. The participants generally accepted the prototype positively, and we found key findings and insights related to enriching driver-to-driver communication for emotion regulation. In conclusion, the emotion-expressing interface can provide additional values, including new and positive driving experiences for drivers. For future work, making a design artifact for speech-based communication and trying to mount an empirical study with quantitative measure would be valuable. Moreover, we should consider the driver-to-driver communication strategies for emotion regulation of drivers based on psychological background. Based on the findings and insights in this study, we will focus on making a framework for designing driver-to-driver communication involving emotion regulation.

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