# Honk? Talk!: Designing Driver-to-Driver Communication Methods for Social Driving

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## Abstract
Driving is a social task where drivers should constantly communicate with one another. However, existing driver-to-driver communication methods have mainly focused on safety-related issues, thereby overlooking the social aspect of drivers' communication needs. We aim to shed light on drivers' needs for richer driver-to-driver (D2D) communication and design future D2D communication methods. Through scenario-based semi-structured interviews, we discovered that drivers wanted to utilize more social cues, deliver more information and vary the scope of their communication. Based on these findings, we derived design ideas for future D2D communication methods and are working on design prototypes.

## Author Keywords
Driver-to-driver communication; Communication; In-vehicle interface; Connected Vehicles;

## CSS Concepts
• Information systems~Information systems applications • Human-centered computing~Human computer interaction (HCI)

*All authors contributed to this work equally.

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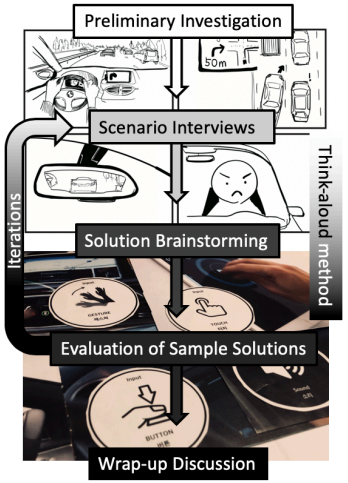


Figure 1: Process of Scenario Interview

| *Input* | *Output* |
|---|---|
| Touch Buttons | Text |
| Gesture | Picture |
| Voice Recognition | Sound |
| Physical Buttons | Symbol / Emoji |
| Other* | Other* |

*Participants were guided to freely suggest other input or output methods on their own.

Table 1: Sample solutions list used in the preliminary user study

## Introduction

Drivers often face situations where they have to share information and their intent to other drivers [3][5][6]. However, communication between vehicles (i.e., by lights and car horns) has remained limited and one-sided [6][16]. Drivers are often frustrated when they fail to communicate their intent, which is known to be part of the cause of road rage [2][5].

Here we focus on communication methods. Through semi-structured interviews with 14 drivers, we were able to gain insight into how to improve drivers' communication methods. We found that they wanted (1) to use social cues (2) more details for objective information, and (3) varying scopes of communication. Based on these findings, we hope to design novel communication methods that can promote social driving.

## Related Work

*Driver-to-driver (D2D) Communication*

D2D communication has been studied from varying perspectives. Much research has focused on safety-related communications [9][10][13], with some studies exploring whether certain messages (e.g. social feedback) would improve driving behaviors [14][15]. Another body of research has focused on cultural or situational attributes of D2D communication, such as the cardinality of interaction, the movement of cars, and the duration of interaction [4][5]. There have also been attempts to develop and evaluate the usability of specific interface designs. Single devices such as rear window informative displays [7] and speech recognition infotainment systems [1] have been tested.

*Social Driving*

While driving, drivers interact with and influence one another [3][5]. Social isolation and conflicts can lead to dissatisfaction and aggressive driving [14][16]. Thus, it is important to facilitate good social relationships and communications between drivers [11].

The advent of "everywhere-available connectivity" [15] provides new opportunities to improve D2D communication and strengthen the social aspect of the driving experience [11][12]. An increasing body of studies has explored the diverse relationships between social actors on the road, including interactions amongst the drivers of autonomous and manual cars [8][11][14][15].

## Method

We conducted scenario-based semi-structured interviews. Through a literature review, we selected four different situations that can be easily observed in today's road environments [6][11][13]. Moreover, two scenarios from each perspective (sender and receiver) were formulated for each situation. We recruited 14 people of both genders and a range of ages (24-56), driving experience (1-36 years), and nationalities (Koreans, Australian, American, and Malaysian).

After a preliminary investigation, each participant was randomly assigned two situations (equivalent to four scenarios). For each situation, the participants were initially interviewed as a sender. They were asked if they had had similar experiences and then to imagine their own hypothetical solutions for better communication. We then provided examples of input and output devices to aid their imagination (Table 1). The same interview was repeated on the receiver side. Afterwards, the participants were interviewed about their solutions

| *Scenario / Perspective* | *Sender* | *Receiver* |
|---|---|---|
| S1. Express positive emotion | Participant expresses gratitude. | Participant receives sign of gratitude. |
| S2. Express negative emotion | Participant expresses anger to a reckless driver. | Participant receives sign of protest. |
| S3. Convey Info. 1:1 | Participant tells other driver that his car's trunk is open. | Participant gets notified on his car's open trunk. |
| S4. Convey Info. 1:N | Participant tells other drivers that she must get to hospital fast. | Participant gets notified by another driver that she must get to hospital fast. |

Table 2: Scenarios used in the preliminary user study

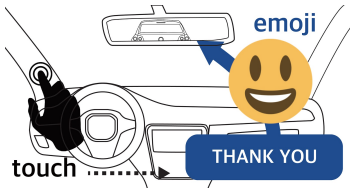


Figure 2: Use case example 1: Expressing gratitude to a following car for yielding via sending smiling emoji.

again and were asked to freely share their thoughts. Each interview took about 60-80 minutes (Fig. 1).

The interview results were analyzed in three steps. First, every researcher reviewed all of the transcripts and shared their main observations. Secondly, we conducted keyword tagging of every single informative sentence. Some sentences were annotated with multiple keyword tags so that the set of keywords could summarize and represent the entirety of the findings. The keywords were then combined into a list of 134 themes. Lastly, we reviewed, linked, and categorized the themes into the main findings.

## Findings

*Drivers Want to Use Social Cues for Affective Messages*

When conveying affective messages such as appreciation, an apology, or a protest, most participants wanted to use social cues to add nuance to their messages.

Most participants perceived that current methods of expressing gratitude or making apologies (i.e., using their hazard lights) were too simplified and not nuanced enough ("It doesn't really feel like I'm communicating with other drivers. [...] It's only like, 'at least I've done something polite." (P7)). Moreover, when complaining to other drivers, many (P1, P2, P4, P7, P8, P11, P14) thought that the actions of honking or using their high-beams were too aggressive and wanted to soften their tone. They commonly feared that the aggressive delivery of a message, although unintentional, could trigger road rage, could startle unconnected drivers, or could misrepresent themselves as an aggressive driver.

Instead, the participants expressed a desire for communication methods that can incorporate more social cues. Some wanted to use their voice to take advantage of intonations and some wished to send an emoji for its facial expressions and cute visual appeal. P2 summarized: "I think emojis would be better. [...] They (emojis) would appeal to someone better (than the other methods)."

*Drivers Want to Put More Details*

Most participants wanted to convey more information via their messages. In particular, P1 pointed out that blinking and honking had often oversimplified the messages. ("When seeing a speeding car, I often think they are weird, but there could be some real urgent situation. It's very confusing"). Participants wanted to use richer communication methods that could reduce information loss, such as text or voice messages.

Such limitations are actually hampering drivers from sharing information with others (e.g., lights are off, etc.) by making communication more cumbersome. Participants were often using alternative methods such as initially honking multiple times to gain the other driver's attention, which many found embarrassing, and then telling the message in person. They said if it were easier to send messages, then they would feel freer to notify other drivers. In addition, participants, from the receiver's perspective, also were willing to react to the signals if they understood them correctly.

*Drivers Want Varying Scopes of Communication*

As the current means of the communication, whether sound or light, does not allow changes of the scope of the signal, these methods often become an obtrusive distraction to nearby drivers. Most participants reported that they had experienced being surprised by car horns, and that they tried not to use them if not necessary.

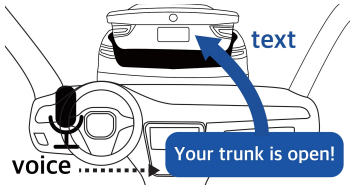


Figure 3: Use case example 2: Sending voice message to the car next ahead that the trunk is open.


Figure 4: Simulation-based prototype for design evaluation

Interestingly, the participants thought drivers' messages could affect social representation on road. When considering the sender's perspective, they thought the receivers could feel embarrassed and be stigmatized as bad drivers. Meanwhile, from the receiver's perspective, they wanted to have control over the messages delivered to them. P14 mentioned: "the messages, if heard by other drivers (without context), can trigger unnecessary prejudice against the receiver. The messages given to me should be shown to me exclusively." Thus, participants wanted to adjust the scope of communication according to the content and purpose of the message.

Aside from the three main findings, we made an interesting observation that the participants preferred different modalities of communication considering the sender and receiver perspectives. As senders, they preferred more auditory methods of communication (i.e., voice and sound) (1) to guarantee that their messages would be received and (2) to deliver the message in detail. However, as receivers, participants preferred "less intrusive" visual methods, i.e., texts or emojis. They thought (1) texts were more polite than voice messages (whether read by the sender or synthesized) and (2) receiving messages itself was cumbersome.

## Initial Design Ideas

We discovered that the drivers wanted "social" communication experiences. However, existing methods for manual vehicles have remained limited in their ability to incorporate social cues, preserve certain information, and adjust the range of communication. Thus, we derived design ideas and are developing interface prototypes based upon these ideas, as shown in Fig. 4.

First, the communication method should be able to incorporate social cues when delivering effective messages. Facial expressions, voice intonations, and verbal explanations can help to convey drivers' affective messages, as shown in Fig. 2.

Second, drivers should be allowed to deliver detailed messages. The communication method should be able to deliver drivers' precise intentions, including relatively complex facts (e.g., "Your trunk is open"). For instance, we can allow the sending of voice or text messages so that users can elaborate on their messages verbally. An example is shown in Fig. 3.

Third, the communication method should allow drivers to select those with whom they want to communicate. Drivers should be able to communicate with single or multiple drivers depending on their intentions. If needed, supplementary technology that can target neighboring cars could be developed accordingly.

## Limitation and Future Work

While all participants wanted driving to be more social, some raised concerns about potential distractions. We plan to explore methods to minimize distractions while facilitating communication. Moreover, further study is needed regarding how to mediate the different communication needs of drivers as senders and receivers.

Based on the initial design ideas, we are building simulation-based prototypes (Fig. 4) and plan to conduct usability evaluations. We hope to design a D2D communication system which can improve drivers' experiences, mediate drivers' different communication needs, and facilitate social driving in near-future semi-automated vehicles.

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