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Who Is (Communicatively More) Responsible Behind the Wheel? Applying the Theory of Communicative Responsibility to TAM in the Context of Using Navigation Technology

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Abstract

By examining how perceived usefulness and ease of use relate to the user's perception (i.e., communicative responsibility), the communicative behavior of the navigation system (i.e., the landmarks used to give directions), and the context of driving (i.e., familiarity of the driving location), this study applies the theory of communicative responsibility to the technology acceptance model to better understand why users are more likely to adopt certain navigation technologies while driving. We hypothesized that users' perceived symmetry in communicative responsibility independently and interactively (with communicative behavior of the navigation system and the driving situation) affects perceived ease of use and usefulness of the navigation system. Consequently, the perceived ease of use and usefulness may affect the user's intention to use the navigation system. This study found that usefulness was a significant predictor of behavioral intention. While driving in a less familiar location, the drivers perceived the navigation system to be more useful. When the navigation system provided location-specific landmarks, such as the name of a local store, drivers who attributed more communicative responsibility to the system were likely to find it useful.

Keywords: Theory of Communicative Responsibility, Technology Acceptance Model, navigation technology, common ground

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Introduction

Previous studies on human-computer interaction (HCI), human-machine communication (HMC), and human-robot communication (HRI) explored a wide range of factors that can enhance the user's intention to accept the technology. For instance, emotional expressions (e.g., Pantic & Rothkrantz, 2003), nonverbal cues (e.g., Samara et al., 2019; Van Erp & Toet, 2015), and the quality of information (e.g., Diop et al., 2019) provided by the machine, the user's perception of the machine (e.g., Fox et al., 2015), and the cultural contexts of the interaction (e.g., Heimgärtner, 2013) are some of the commonly examined factors that are especially relevant to communication science. These factors can be categorized into three groups: communicative behavior of the machine, perception of the user, and the context of the interaction. Technology acceptance literature has extensively examined the effect of these factors individually. There are relatively fewer studies that integrate these three strands of factors into a single, theoretical, comprehensive model.

Scholars have studied HMC by comparing it against human-human interaction (e.g., J. Meyer et al., 2016; Waytz et al., 2010). As human-human interaction is the most common and extensively studied communication context, theories rooted in interpersonal communication can help us better understand HMC (e.g., the nuance of when and how people apply scripts from interpersonal communication to interact with machines; Gambino et al., 2020). To provide empirical evidence regarding the applicability and contributions of interpersonal theory in improving our understanding of HMC, this study applies the theory of communicative responsibility (CRT) to the context of HMC. According to CRT, interlocutors perceive the amount of responsibility they and their communicative partners bear to create a shared understanding (Aune et al., 2005). The communication context may influence the perceived communicative responsibility and dictate the communicative behavior. By considering the interplay between perceived communicative responsibility, the communicative behaviors, and the communication context, the interlocutor can evaluate the appropriateness of the interaction.

This study integrates CRT into the technology acceptance model (TAM; Davis, 1989) to better understand the mechanism that underlines why users are more likely to adopt certain technologies. As the original study of CRT examined human-to-human interaction in the context of navigation (i.e., giving directions), this study focuses on understanding users' willingness to use a navigation system while driving. It is hypothesized that users' perceived symmetry in communicative responsibility independently and interactively (with communicative behavior of the navigation system and the driving situation) affects perceived ease of use and usefulness of the navigation system. Consequently, the perceived ease of use and usefulness affects their intention to use the navigation system.

Theory of Communicative Responsibility

According to Aune et al. (2005), CRT postulates that interlocutors and communicative parties make judgments about how much responsibility each of them bears to create a mutual understanding (i.e., co-creation of particular meaning or thought in the listener's mind as intended by the speaker, Clark, 1992). From Grice's perspective (1989), the common goal of communication is to establish a shared understanding and knowledge. In other words, when communicating, people have the responsibility and commitment to engage in collaborative efforts in achieving this goal (Geurts, 2019). This responsibility is called communicative responsibility. The communicative responsibility is what communicative partners recognize, estimate, and consider while using conversational implicature (i.e., the notion of conveying information beyond what is apparent; Ahlsén, 2008) and inference-making (i.e., interpretation and comprehension of conversational implicature; Ahmed & Shazali, 2010). The extent to which the communicative party's implicature can be interpreted by the other party is at the heart of successful communication (Mahmood, 2015).

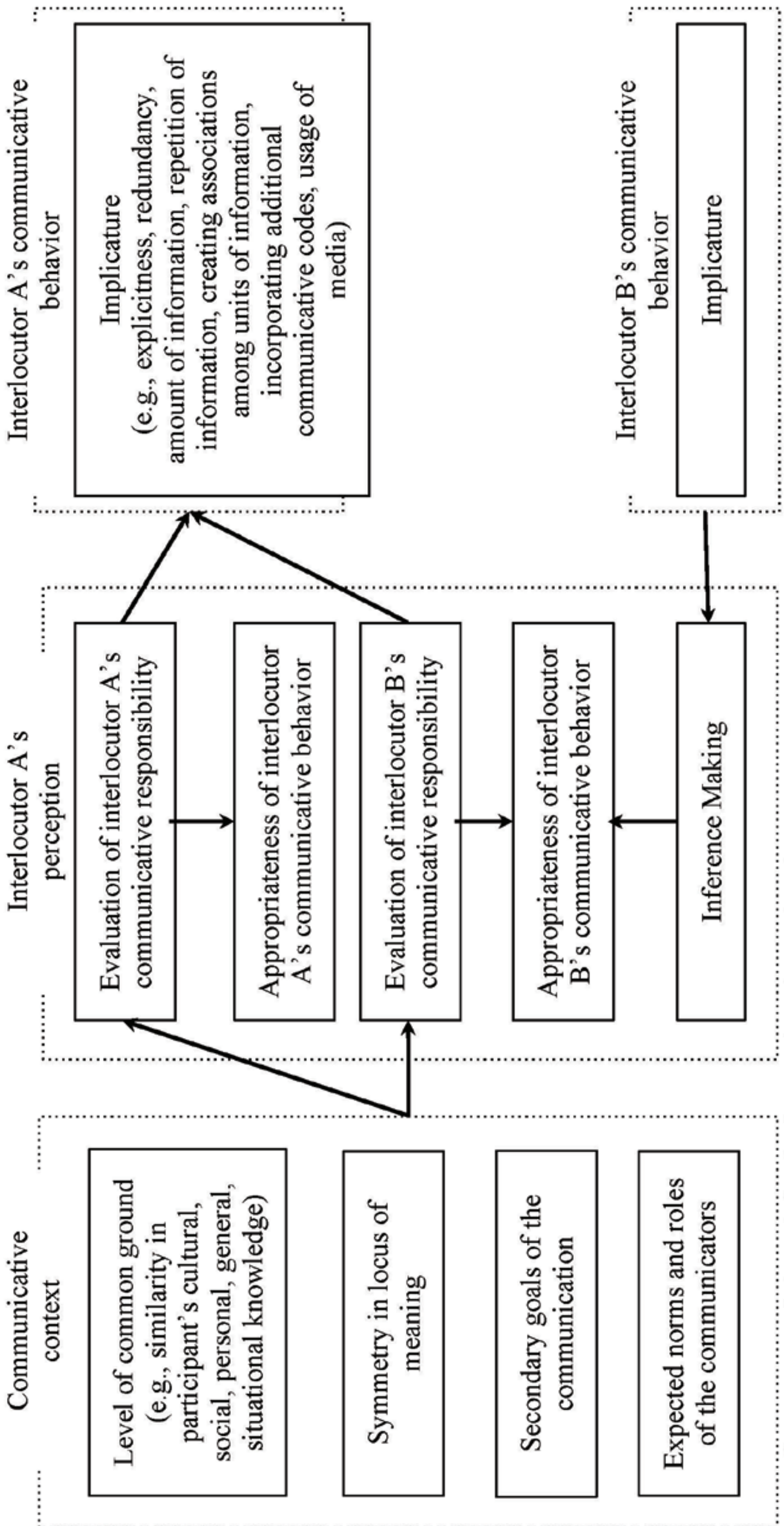
CRT predicts that (a) people adjust their communicative behaviors (i.e., how they express meaning either verbally or nonverbally) according to the relative level of communicative responsibility they have compared to the communicative partner and (b) people judge the appropriateness of their partner's communicative behavior based on the relevant level of communicative responsibility. See Figure 1 for the conceptual map of the predictors and the determinants of CRT as explicated by Aune et al. (2005). For example, when a traveler asks a resident for directions, the resident is responsible for making sure that the traveler understands how to get to the destination, while the traveler is responsible for understanding the provided directions. As the traveler is less familiar with the location, the resident is likely to have a higher communicative responsibility than the traveler. If the resident provides vague directions without reference to easily noticeable landmarks, the traveler will have difficulty understanding the directions (i.e., having difficulty in inference-making). In this case, the resident's communicative behavior is inconsistent with the communicative responsibility. Therefore, the traveler may perceive the resident's communication as inappropriate as the provided directions were not helpful.

Communicative responsibility is a function of common ground. Common ground refers to the mutual knowledge that the interlocutors share (Stalnaker, 1978). Interlocutors' mental states, sociocultural background, prior experience, familiarity with the communication context, and roles in the communication may affect the availability of resources to create meaning out of the communication and the level of common ground (Kecskes & Zhang, 2009; Lau et al., 2001). When there is a lack of common ground, the communicative responsibility is less likely to be shared equally. For example, consider the following two situations:

> **Situation 1:** A and B are both born and raised in the same neighborhood. They are attending the same school.
>
> **Situation 2:** A is new to a neighborhood, while B is born and raised in the neighborhood. From today on, A will attend B's school.

In Situation 1, A and B have a high common ground (i.e., similar knowledge about how to navigate to school). Hence, they are equally responsible for the collaborative effort to arrive at their destination. In Situation 2, A and B will have little common ground regarding the map of the neighborhood. In this case, their communicative responsibility is asymmetrical; B has a higher communicative responsibility than A because of the difference in familiarity with the area.

FIGURE 1 Central Mechanisms of CRT From One Interlocutor's Perspective



Note. See Aune et al. (2005) for further explanations of each concept.

While communicating, people have the innate tendency to monitor the level of common ground. People are cooperative in their communication (Grice, 1989). They build on the conversation and speak in ways that the other person can understand because people can engage in perspective-taking to estimate how much information is mutually shared (Fussell & Krauss, 1989). Based on the expected information that the partner knows, people present information and communicate in a way that can be interpreted as they intended (Clark & Wilkes-Gibbs, 1986; Kecskes & Zhang, 2009). Going back to the two situations mentioned above, B expects A to have little knowledge about the neighborhood. B is likely to attribute less communicative responsibility to A. This indicates that B needs to be explicit, talk in great detail, repeat what was said, and avoid giving directions using landmarks that are specific to the neighborhood to increase the chances of A fully understanding the directions as intended by B (Aune et al., 2005; Lau et al., 2001).

Applying CRT to HMC

The meaning-making process in human-human interaction and HMC are not identical but have overlaps (Gambino et al., 2020; Waytz et al., 2010). The former involves two entities that have the autonomous, biological, and psychological ability to formulate, receive, comprehend, and respond to the communicated message while integrating the complexities of social, environmental, and cultural contexts (Fortunati & Edwards, 2020). Machines only *simulate* having a communicative competence and intelligence (at least for now). Therefore, it is the user who interprets the communication as if machines have the social capacity (Fortunati & Edwards, 2020). For example, interlocutors assume that the other person is telling the truth (i.e., factually correct information to the best of his or her knowledge) unless there is evidence to believe otherwise (see Levine, 2019). By default, communication is built on people telling the truth and cooperating with others to create a common understanding. Similarly, people perceive machines to provide factually accurate information, are agreeable, and unconditionally accept the user's request, but have limited capacity to make evaluative judgments and understand complex human language, social context, and emotional cues (Gambino & Liu, 2022). Consequently, HMC is characterized by people having less concern about impression management (J. R. Meyer, 2009; Veletsianos et al., 2008), burdening or inconveniencing the machine (Gambino & Liu, 2022), and risks of self-disclosure (Ta et al., 2020).

This study applies CRT to the context of HMC for the following reasons. First, interpersonal communication theories and paradigms can be helpful in understanding HMC (Fortunati & Edwards, 2020; Gambino & Liu, 2022; Spence, 2019). As interpersonal communication is the most well-known and extensively studied context, it provides a comparable yardstick. Second, the foundation of CRT is aligned with the primary goal of HMC. Like in interpersonal interaction, fostering a mutual understanding is critical for a successful HMC and HCI (Chai et al., 2014; Stubbs et al., 2007). Last, CRT may provide an answer to one of the "enduring problems" related to effective HMC: uncovering the development of common understanding and shared perception between human and machine (Patterson & Eggleston, 2018). What lies beneath the roadblock to understanding HMC is "a lack of critical knowledge about human cognition" (Patterson & Eggleston, 2018, p. 249). CRT offers a perspective to understand human cognition in the communicative process.

Empirical evidence suggests how CRT predictions apply to HMC context. People use physical, linguistic, and social cues to estimate what the machine knows (Kiesler, 2005). For instance, people evaluate how much common ground is being established based on the occupation and the persona (e.g., personal history, memory, and preference) of the machine (M. K. Lee & Makatchey, 2009). People are likely to include more details in their message when they perceive the machine to share less common ground (Kiesler, 2005).

In particular, CRT is applicable to the driving context of HMC. Using a navigation system is synonymous with the interpersonal communication context given above and Aune et al.'s (2005) experiment. According to CRT, the driver and the navigation system can share different levels of communicative responsibility. The communicative responsibility may change depending on the context of the situation. For instance, a driver expects the navigation system to have a higher communicative responsibility when driving in an unfamiliar location compared to driving in a familiar location. However, if drivers estimate the level of common ground based on their communicative role, the situational context may have a negligible impact on the communicative responsibility. In Hinds et al.'s study (2004), people were asked to complete a task with a computer agent. The study suggested that when the computer agent has a supervisory position but does not have the necessary skills, the subordinate human evaluated the interaction negatively. Given the expected role and duties of a supervisor, the computer agent is expected to communicate in a way that helps the subordinate to understand what needs to be done to complete the task. Behaving inconsistently with the expectation made the subordinate to evaluate the supervisor negatively. In the context of driving, the navigation system's role is to provide accurate directions to help the driver get to the destination. Therefore, the driver may consistently perceive the navigation system to have high communicative responsibility. Therefore, the following research question is asked:

> **RQ1:** Do participants perceive the navigation system to have more communicative responsibility than themselves when driving in an unfamiliar location as opposed to driving in a familiar location?

Technology Acceptance Model

Technology Acceptance Model (TAM) is a widely used theoretical framework that explains why people accept and adopt certain technologies. According to Davis (1989), people are more inclined to use a technology that is perceived to be useful (i.e., how well the technology enhances the user's performance) and easy to use (i.e., how effortless the user can use the technology). This parsimonious model is empirically well-validated across multiple meta-analyses and literature reviews (Al-Emran & Granić, 2021; Granić & Marangunić, 2019; Y. Lee et al., 2003; Ma & Liu, 2004; Marangunić & Granić, 2015; Tao et al., 2020; Yucel & Gulbahar, 2013).

Despite the salience and popularity of TAM, it is not without limitations (see Bagozzi, 2007). For instance, critics of TAM elaborated on the lack of comprehensiveness. To overcome the shortcomings of TAM, scholars have continuously developed various models to study the acceptance of technology: Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003), UTAUT2 (Venkatesh et al., 2012), TAM2 (Venkatesh

& Davis, 2000), TAM 3 (Venkatesh & Bala, 2008), and many extended versions of TAM (e.g., Y. Lee et al., 2003; Granić & Marangunić, 2019). UTAUT integrated elements across eight models, including TAM, and UTAUT2 incorporated three additional constructs to UTAUT. TAM2 extended TAM by adding external factors that affect perceived usefulness (e.g., subjective norm, imagination, job relevance, output quality). TAM3 combined TAM2 and various other determinants of perceived ease of use, resulting in a total of 13 factors (excluding the interaction effects) that affect perceived usefulness, perceived ease of use, and consequently behavioral intentions. Like TAM2 and TAM3, other extended versions of TAM (e.g., Go et al., 2020) also have introduced other external factors impacting the two core predictors of behavioral intention (i.e., perceived usefulness and perceived ease of use).

To have a better understanding of how the context of communicative interaction affects acceptance of navigation technology, this study incorporates CRT into TAM. We use TAM as the theoretical backbone instead of other recent alternatives for the following reasons: (a) TAM is parsimonious and extensively validated; (b) TAM has been well-applied to technologies related to driving; (c) TAM is continuously growing; (d) despite all the determinants added to TAM, the factors that are related to communicative interaction are often overlooked.

TAM is parsimonious and extensively validated (Al-Emran & Granić, 2021; Y. Lee et al., 2003; Marangunić & Granić, 2015). Its simplicity and understandability encouraged scholars to use TAM as their theoretical framework (Legris et al., 2003). Consequently, various studies related to technology acceptance are somewhat standardized and comparable (Y. Lee et al., 2003), which facilitates the accumulation of knowledge. According to Yucel and Gulbahar's qualitative content analysis of TAM research (2013),

> although numerous attempts have been made to add other variables to existing ones, the main variables that the 'Technology Acceptance Model' was based on remain the most effective . . . This finding brings us to the understanding that whatever the shape, color, size, and property of the technology, acceptance of that technology can ultimately be determined by using the same variables. (p. 106)

Considering the novelty of CRT, which introduces the determinants that encapsulate the context of communicative interaction, utilizing TAM enables this study to be rooted in the foundation of technology acceptance literature.

TAM has been well-applied to technologies related to driving. Initially, TAM was introduced to explain the adoption of computers in 1989 (Davis). Since then, scholars applied TAM to various technologies, including navigation systems (Eriksson & Strandvik, 2009; Park et al., 2015; Park et al., 2013). Although UTAUT (the more comprehensive model of technology acceptance) outperforms TAM on average (Yucel & Gulbahar, 2013), Rahman et al.'s study (2017) on advanced driver assistance systems demonstrated that TAM explained significantly more variance than UTAUT. This indicates that the different models of technology acceptance can vary in their performance depending on the technology and the context in which it is used.

TAM is continuously growing and expanding as new determinants are introduced to the core variables (i.e., perceived usefulness, perceived ease of use, and behavioral intentions).

TAM3 provides 32 determinants (including interaction effects) of perceived usefulness and perceived ease of use, and 9 determinants of behavioral intention (Venkatesh & Bala, 2008). Similarly, UTAUT also provides a total of 41 independent variables for predicting the intention of accepting the technology (Bagozzi, 2007; Venkatesh et al., 2003). The continuous expansion of the model with a large number of antecedents has multiple drawbacks. First, from a statistical perspective, the model is subject to redundancy, over-fitting, and multicollinearity (Todeschini et al., 2004), which is rarely addressed or discussed in the recent models of technology acceptance. Second, the recently developed models fall short in providing strong theoretical reasons for at least one of the three effects: (a) the direct effect of the new determinant on perceived usefulness and ease of use; (b) the discrete and independent effect of the new determinant from every other determinant; (c) the interactive effect of multiple determinants on perceived usefulness and ease of use. Third, the recent advancements have not fully replaced TAM. New versions and extensions of TAM are being introduced without acknowledgment of TAM2 and TAM3 (e.g., Al Shamsi et al., 2022; Sagnier et al., 2020; Wang et al., 2020). Therefore, this study focuses on TAM's core variables and integrates CRT to account for the context of communicative interaction between humans and machines.

The communicative interaction is fundamental to understanding HMC as the human and the machine are building a communicative relationship (Guzman, 2018). In the context of HMC and HCI, TAM research has examined how users' experience and attitudes (e.g., Bröhl et al., 2016), and hedonic values (e.g., de Graff et al., 2019; Park & Kwon, 2016) about the artificial intelligence affect the perceived usefulness and ease of use. However, little is studied about how to systematically examine the socio-relational aspect of the communication between the human and the machine. Therefore, the integration of CRT can resolve at least one limitation of TAM. Although the compliance process can occur when a person sees oneself in relation to another person, agent, and group, TAM (on its own) does not take group, cultural, and social contexts into account (Bagozzi, 2007).

By anatomizing the communication process using CRT, this study provides three external factors that influence perceived ease of use and usefulness of a navigation technology: the context of the interaction (i.e., location), the driver's perception (i.e., communicative responsibility), and the technology's communicative behavior (e.g., how the directions are provided). As outlined in CRT, the driver's familiarity with the location and the perceived communicative responsibility affects the dynamics of the interaction. When driving in an unfamiliar location, the driver may be more dependent on the navigation system as the driver has limited knowledge about the directions. The driver may also rely heavily on the navigation system because the purpose of the navigation is to assist the driver by providing accurate directions. In both situations, the driver attributes a large amount of communicative responsibility to the navigation system and finds its interaction valuable for achieving the communicative goal of getting to the destination. Consequently, the driver is likely to consider the navigation system as easy to use and useful. Additionally, in certain situations (e.g., driving in an unfamiliar location) and to some drivers (i.e., drivers who expect the navigation system to provide simple and highly visible landmarks), how the direction is provided matters. When the navigation system provides the directions using general landmarks, such as parks, woods, and lakes, drivers may easily find their way as minimal a priori knowledge is required to notice these landmarks. Drivers may find the directions including location-specific landmarks, such as the name of a store that is less available in other places, less helpful and difficult to understand, especially when they consider the navigation to have more responsibility in helping the driver understand the directions. The following hypotheses are proposed to examine these three factors that may determine a driver's intention to use a navigation system:

> **H1:** Participants will perceive the navigation system to be (a) easy to use and (b) useful when they perceive the navigation system to have more communicative responsibility than themselves.

> **H2:** Participants will perceive the navigation system to be (a) easy to use and (b) useful when it uses general landmarks (i.e., natural landmarks) to give directions compared to location-specific landmarks (i.e., stores).

> **H3:** Participants will perceive the navigation system to be (a) easy to use and (b) useful when they are driving in an unfamiliar location compared to a familiar location.

> **H4:** The relationship between asymmetry in communicative responsibility (i.e., the driver having more) and the perceived (a) ease of use and (b) usefulness of the navigation system will be moderated by the types of landmark: the relationship will be more negative when the navigation uses general landmarks (i.e., natural landmarks) to give directions instead of location-specific landmarks (i.e., stores).

> **H5:** The relationship between asymmetry in communicative responsibility (i.e., the driver having more) and the perceived (a) ease of use and (b) usefulness of the navigation system will be moderated by the types of location: the relationship will be more negative when driving in an unfamiliar location instead of a familiar location.

> **H6:** Participants will have a higher intention to use the navigation system when they perceive it as (a) easy to use and (b) useful.

Method

Participants and Procedure

A total of 314 participants were recruited from SurveyMonkey's United States online panel in May 2020. Those who had a driver's license were eligible to participate. The data from 216 participants were used for the main analyses after removing those that did not pass the attention-check questions (n = 91) or did not answer most of the survey questions (n = 7). There were four attention-check questions to reassure the quality of the responses (Paas & Morren, 2018). To reassure that participants could hear the audio clip of the navigation system, the first question asked participants to play a provided audio clip (i.e., siren) and choose the sound they heard from a list: bark, car, horn, rain, and siren. Twenty-six participants incorrectly identified the audio clip. The second and third attention-check question filtered out participants who provided inconsistent and implausible answers: 3 participants' driving experience exceeded their age; 19 participants indicated that they have never used a GPS and a navigation system but stated that their existing GPS was useful. The last question (i.e., select "disagree") eliminated 43 participants who did not carefully read the questions or provided straight-line grid answers. Around half of the analyzed participants were women (n = 124, 57.41%). Their age ranged from 18 to 87 (M = 42.58, SD = 16.19). As for ethnicity, the majority of the participants (n = 150, 69.76%) were Caucasian. Hispanic or Latino (n = 30, 13.95%) and Asian or Asian American (n = 19, 8.83%) participants followed. African American (n = 10, 4.65%), Native American or Alaska Native (n = 4, 1.86%), and participants of other ethnicities (n = 2, 0.93%) also took part in this study. Although their driving experience varied (M = 23.10 years, SD = 16.66), it was not significantly related to the dependent variables.

The participants were randomly allocated to one of the four versions of the survey. The four versions were created by combining two locations (i.e., a hypothetical city in the US or South Korea) with two communicative behaviors of the navigation system (i.e., using location-specific landmarks or general landmarks). Fifty-three participants interacted with the navigation system that used location-specific landmarks in the United States; 46 interacted with the navigation system that used general landmarks in the United States. Fifty-one and 47 participants interacted with the navigation system in South Korea that used location-specific and general landmarks, respectively.

The participants were told that they were visiting a friend living in either a different state or a different country. They then listened to directions given by the navigation system while imagining themselves driving from a hotel parking lot to a restaurant to meet their friend for dinner. Using the default logic in the online survey platform, the relevant section of the map was shown to the participants while the navigation system provided directions. For every crossroads, participants chose a direction. This process continued until the participants arrived at the final destination. The entire map of the hypothetical cities are provided in Appendix A and B. The map was developed by making minor changes to the original study that tested CRT (Aune et al., 2005): the map of a South Korean city used culturally relevant streets (e.g., Songcheon-ro) and store names (e.g., Lotteria). In the location-specific landmark condition, the navigation system used names of specific stores and brands (e.g., Hyundai Department Store, Jack in the Box) while giving directions. In the general landmark condition, the navigation system provided directions with reference to the presence of parks, lakes, and woods instead of their names. After arriving at the destination, they completed the survey, which contained the following measures. The survey lasted around 9 minutes. Each participant received $4 for their contribution.

Measures

By utilizing the items developed by Aune et al. (2005), the perceived communicative responsibility of the participants and the navigation system were each measured with five items on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). "It is expected of me to make an extra effort to understand the directions given by this navigation system" and "compared to me, this navigation system has a much bigger responsibility for helping me understand how to get to the destination" are examples of items measuring the participants' and their perceptions of the navigation system's communicative responsibility, respectively (See Appendix C for all items). Both measures of communicative responsibility were reliable, Cronbach's alpha (α) = .84 and McDonald's omega (ω) = .86 for the driver; α = .86 and ω = .88 for the navigation system.

After taking the mean of the two communicative responsibility scores, the difference between the two averages was used to measure how the communicative responsibility is shared between the participants and the navigation. A score of 0 indicates that the participants perceived the communicative responsibility to be symmetrical and equally shared. A positive score indicates the participants attributed themselves to have a higher communicative responsibility, more responsibility in making sense out of the communication, than the navigation system. The difference score, which is referred to as communicative responsibility hereinafter, ranged from –4 to 3.6 ($M = -0.07$, $SD = 1.34$).

Perceived ease of use (e.g., "I think that learning to operate this navigation system is easy for me") and perceived usefulness (e.g., "overall, I find this navigation system to be very useful") were each measured by taking the mean of the three items on a 5-point Likert scale. The items were adopted from C. F. Chen and Chen (2011), Davis (1989), and Park et al. (2015). The participant's intention to use the navigation system was measured with three items on the same Likert scale (C. F. Chen & Chen, 2011; Venkatesh & Davis, 2000). All the measures were reliable, α = .78 and ω = .80 for perceived ease of use; α = .83 and ω = 0.85 for perceived usefulness; α = .89 and ω = .90 for intention to use.

Results

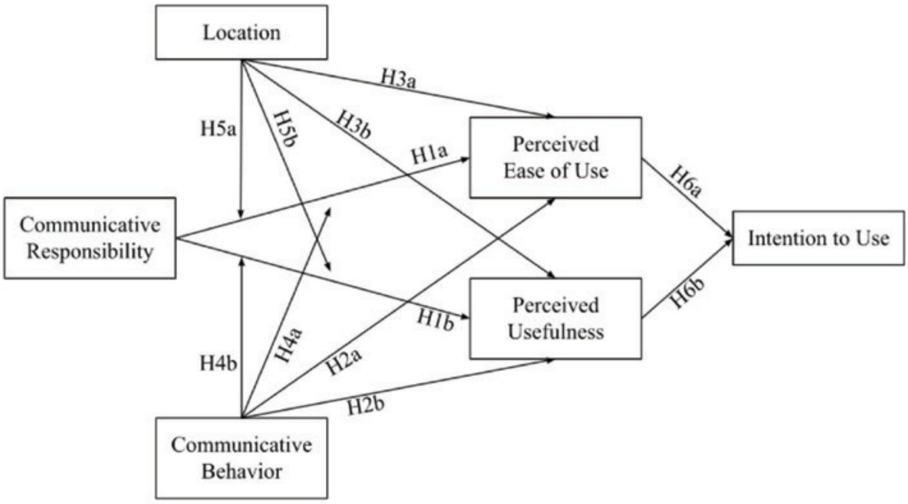
Manipulation Check

The two locations were chosen to reflect different levels of familiarity. The city in the US was intended to be a familiar environment compared to the city in South Korea. Participants were asked to rate their familiarity with the names of the stores, streets, and general landmarks. All three independent-sample *t*-tests indicated that participants were more familiar with the stores, streets, and general landmarks in the US city than in the South Korean city, $t_{store}\ (214) = -7.01$, $p < .001$; $t_{street}\ (214) = -13.15$, $p < .001$, and $t_{natural\ landmark}\ (214) = -5.26$, $p < .001$.

Hypothesis Testing

RQ1 asked if communicative responsibility differed between the two locations. Considering the predictions of CRT, the communicative responsibility should be higher when driving in a familiar location. However, the participants might prioritize the role of the navigation system over the given context of driving. In this case, the communicative responsibility should be a negative score regardless of the location. The result of an independent *t*-test indicates that the communicative responsibility did not differ significantly based on the driving location, $t\ (216) = -0.45$, $p = .66$. The communicative responsibility for driving in a familiar location ($M = -0.12$, $SD = 1.46$) and an unfamiliar location ($M = -0.03$, $SD = 1.22$) was slightly negative but did not deviate significantly from zero, $t\ (215) = -0.80$, $p = .42$.

FIGURE 2 Hypothesized Mediated Moderation Effect



The six hypotheses predicting mediated moderation on behavioral intention were tested with model 10 of the process analysis (Hayes, 2018). According to the hypothesized model as illustrated in Figure 2, the communicative responsibility affects the perceived intention to use the navigation system. This relationship is mediated by perceived ease of use and usefulness. The relationships between communicative responsibility and the two predictors of TAM are moderated by the context of communication (i.e., location) and the communicative behavior of the navigation system. The location and communicative behavior were dummy coded with the familiar location and the location-specific landmarks as the reference group (See Table 1 for pairwise correlations of the variables). The process analysis provides the results of three OLS regressions predicting perceived ease of use, usefulness, and intention to use the navigation system (See Table 2). A nonparametric bootstrapping is conducted to analyze the direct and indirect effects of communicative responsibility on the usage intention (See Table 3).

TABLE 1 Pairwise Correlations of the Variables

	1	2	3	4	5
1. Location[1]					
2. Communicative Behavior[1]	0.09				
3. Communicative Responsibility	0.03	0.05			
4. Perceived Ease of Use	0.14*	0.12	−0.12		
5. Perceived Usefulness	0.19**	0.04	−0.15*	0.66***	
6. Intention to Use	0.19**	0.1	−0.12	0.46***	0.64***

Note: *$p < .05$. ** $p < .01$. ***$p < .001$.[1] Location and communicative behavior are dummy coded variables with the familiar location and location-specific landmarks as the reference group, respectively.

TABLE 2 Summary of Process Analysis

	Outcome Variable								
	Perceived Ease of Use			Perceived Usefulness			Intention to Use		
	B	*SE*	*t*	B	*SE*	*t*	B	*SE*	*t*
CR	−0.16	0.06	−2.52*	−0.17	0.06	−2.66*	−0.04	0.06	−0.70
CB	0.19	0.10	1.85	0.08	0.10	0.78	0.09	0.10	0.92
Location	0.18	0.10	1.81	0.27	0.10	2.56*	0.14	0.10	1.47
CR × CB	0.17	0.08	2.27*	0.20	0.08	2.60*	−0.06	0.07	−0.86
CR × Location	−0.01	0.08	−0.15	−0.07	0.08	−0.88	0.14	0.07	1.92
PEOU	–	–	–	–	–	–	0.07	0.08	0.82
PUSE	–	–	–	–	–	–	0.70	0.08	8.45**
	adjusted R^2 = .04 *F* (5, 210) = 3.15**			*adjusted* R^2 = .07 *F* (5, 210) = 4.22**			*adjusted* R^2 = .41 *F* (7, 208) = 22.96**		

Note: *$p < .05$. **$p < .001$. Location and CR are dummy coded variables with the familiar location and location-specific landmarks as the reference group, respectively. CR = Communicative Responsibility, CB = Communicative Behavior, PEOU = Perceived Ease of Use, PUSE = Perceived Usefulness.

TABLE 3 Conditional Indirect Effects of Communicative Responsibility on Intention to Use

Moderator		Effect	SE	Lower CI	Upper CI
Location	Communicative Behavior				
Mediator: Perceived Ease of Use					
Familiar Location	General Landmark	−0.01	0.02	−0.06	0.01
	Location-Specific Landmark	0.00	0.01	−0.01	0.03
Unfamiliar Location	General Landmark	−0.01	0.02	−0.07	0.02
	Location-Specific Landmark	0.00	0.01	−0.02	0.02
Mediator: Perceived Usefulness					
Familiar Location	General Landmark	−0.12	0.06	−0.26	−0.01
	Location-Specific Landmark	0.02	0.07	−0.11	0.18
Unfamiliar Location	General Landmark	−0.17	0.06	−0.31	−0.05
	Location-Specific Landmark	−0.03	0.04	−0.11	0.06

Note: CI = 95% bootstrapped confidence intervals (*n* = 5000).

The model predicting perceived ease of use was statistically significant, F (5, 210) = 3.15, $p < .01$, *adjusted* $R^2 = .04$. The communicative responsibility was negatively correlated to perceived ease of use, and this relationship is moderated by the communicative behavior of the navigation system ($B = 0.17$, $SE = 0.08$). Simple slope analysis was conducted by alternating the reference group for communicative behavior (See Figure 3A). The results indicate that the negative relationship between communicative responsibility and perceived ease of use is evident when the navigation system provided directions with location-specific landmarks ($B = -0.16$, $SE = 0.06$, $t = -2.52$, $p = .01$), while the relationship is not statistically significant when general landmarks were used ($B = 0.02$, $SE = 0.06$, $t = 0.24$, $p = .81$). Therefore, the data is consistent with H1a. Although the relationship between communicative responsibility and perceived ease of use differed based on the communicative behavior of the navigation system, the direction of the difference was opposite of H4a. When the navigation system was referencing location-specific landmarks, the participants who perceived the navigation system to have higher communicative responsibility found the navigation system to be easier to use.

The model predicting perceived usefulness of the navigation system was statistically significant, F (5, 210) = 4.22, $p < .01$, *adjusted* $R^2 = .07$. Consistent with H1b and H3b, the participants found the navigation system to be more useful when they attributed more communicative responsibility to it ($B = -0.17$, $SE = 0.06$, $t = -2.66$, $p < .01$) and when using it in an unfamiliar location ($B = 0.27$, $SE = 0.10$, $t = 2.56$, $p = .01$). The interaction between communicative responsibility and the communicative behavior of the navigation system was significant ($B = 0.20$, $SE = 0.08$, $t = 2.60$, $p = .01$). In contrast to the predicted pattern in H4b, the participants who perceived the navigation system to have more communicative responsibility found it to be more useful when location-specific landmarks were used (See Figure 3B). When the navigation system gave directions by using general landmarks, the participants' perceived communicative responsibility did not affect the perceived usefulness ($B = 0.03$, $SE = 0.06$, $t = 0.50$, $p = .62$).

The model with the intention to use the navigation system as the outcome variable was significant, F (7, 208) = 22.96, $p < .01$, *adjusted* $R^2 = .41$. The relationship between perceived ease of use and behavioral intention was not statistically significant ($B = 0.07$, $SE = 0.08$, $t = 0.82$, $p = .41$), which indicates that the data was inconsistent with H6a. Consistent with H6b, participants who perceived the navigation system to be useful had higher intention to use it ($B = 0.70$, $SE = 0.08$, $t = 8.45$, $p < .001$). The participant's communicative responsibility did not have statistically significant direct effects on the intention to use the navigation system. The results of conditional indirect effects indicate that the effect of communicative responsibility on intention was mediated by perceived usefulness, but not perceived ease of use. The mediated relationship of perceived usefulness was moderated by the communicative behavior of the navigation system. Regardless of the location, the participants who attributed more communicative responsibility to the navigation system were more likely to find it useful and showed greater intention to use it when the navigation system provided directions by referring to location-specific landmarks (See Figure 4 on page 218).

FIGURE 3A Simple Slope Analyses of Moderation Effect

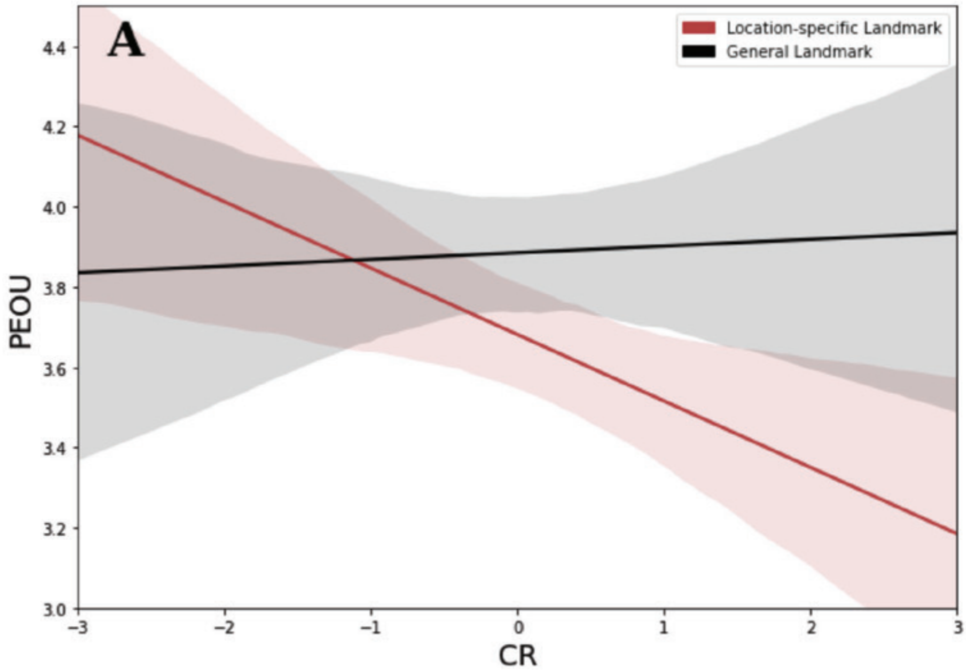
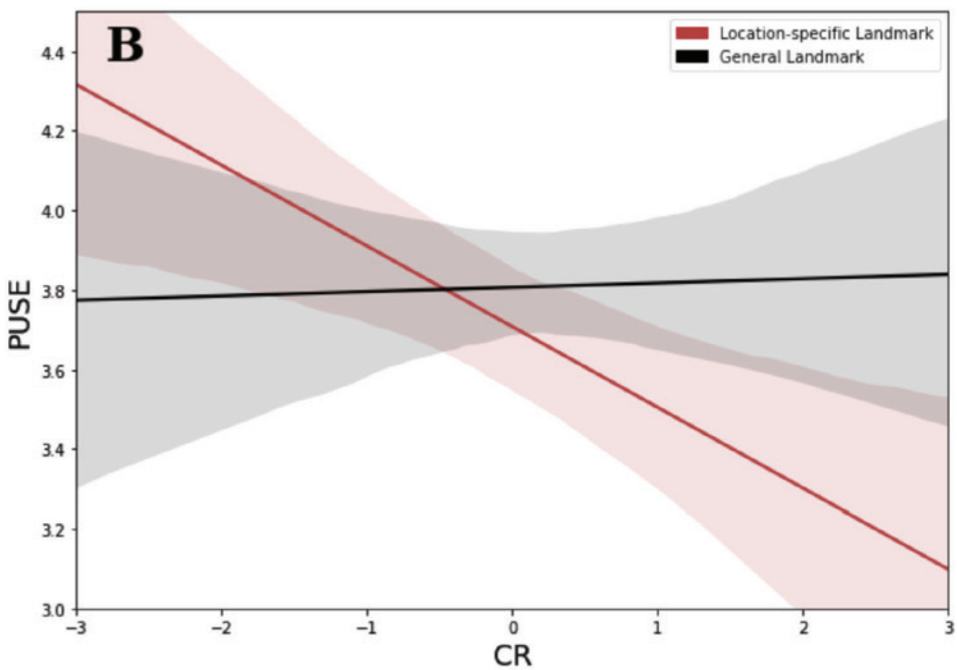
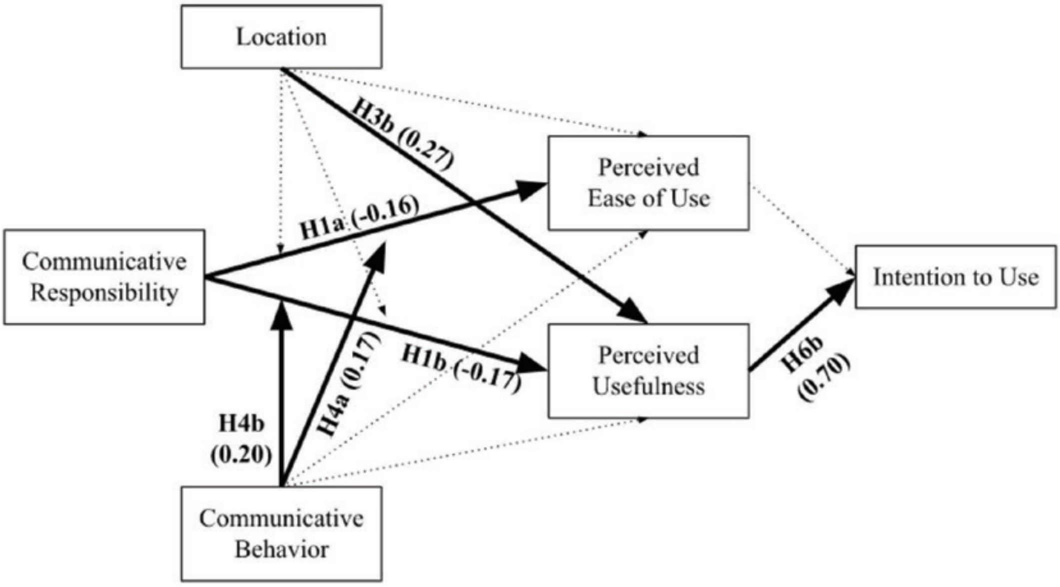


FIGURE 3B Simple Slope Analyses of Moderation Effect



Note: PEOU = Perceived Ease of Use, PUSE = Perceived Usefulness, CR = Communicative Responsibility (a positive score indicates that the driver had higher CR than the navigation system).

FIGURE 4 Analysis of Mediated Moderation Effect



Note: The statistically significant relationships are in bold. H4a and H4b were significant but opposite to the predicted patterns. The standardized coefficients are in parentheses.

Discussion

This study examines one of the central aspects of HMC: the process of meaning-making (Guzman, 2018). We examined the driver's intention to use a navigation system by integrating TAM and CRT, which includes the driver's perception of communicative responsibility, the communicative behavior of the navigation, and the context of interaction. Drivers were more likely to use the navigation system if they perceived it to be useful. The usefulness was influenced by the context (i.e., familiarity with the location) and the interaction between the driver's perception and how the navigation system provided the direction. While driving in a less familiar location, the drivers found the navigation system to be more useful. Additionally, when the navigation system provided location-specific landmarks (e.g., the name of a local store), the drivers who attributed the navigation system to have more communicative responsibility were likely to find the navigation system useful. When generic landmarks were used, the driver's perception was not significantly related to perceived usefulness.

When the direction provided by the navigation system referenced location-specific landmarks, the participants who perceived it to have higher communicative responsibility found it to be easier to use and more useful. This is inconsistent with the predictions derived from CRT. However, the findings may be consistent with other studies that examined the driver's intention to use a navigation system. C. C. Chen and Tsai (2019) found that completeness, informativeness, and accuracy of information provided by location-based services affect the perceived ease of use. Additionally, drivers found navigation systems that allow them to be more accurately aware of their location more useful (Park et al., 2015; Park & Kim, 2014). Service quality is an important factor affecting the driver's intention to use a navigation system (Park et al., 2015): providing accurate locational information is the main service of the navigation system. Therefore, location-specific landmarks, such as store names, are perceived to be more concrete and precise information as compared to generic landmarks, such as parks and lakes (without specifying the names of these venues). The drivers who perceived the navigation system to have more communicative responsibility in creating a mutual understanding to achieve the goal of getting to the destination are more likely to find the precise and accurate reference to landmarks as helpful.

The familiarity with the location is the other predictor of the drivers' perceived usefulness of the navigation system. Consistent with basic intuition, the drivers considered navigation to be useful when driving in an unfamiliar location. This implies that the user experience can be enhanced by integrating situational awareness to machines. According to Endsley (2000), situational awareness refers to knowing what is going around the agent. By considering the driving patterns and the navigation history, the navigation system can know whether the location is familiar or unfamiliar to the driver. As adoption of the navigation system is likely to be triggered in an unfamiliar driving location, the navigation system can further seek to improve its quality and provide a satisfying experience to the drivers to maximize their perceived usefulness.

This study contributes to the literature by providing and empirically validating a theoretical framework that can be used in HMC research: the framework focused on the process of meaning-making and the exchange of communicative message. Aune et al. (2005) first introduced CRT and also suggested how it can be applied beyond interpersonal communication. This study is the first to empirically test this. The theoretical framework is important because it can potentially provide guidelines for selecting specific social abilities that can be integrated into machines. According to Heerink et al. (2009), the social ability of the computer agent improves the user's interaction with it. Based on the findings of this study, estimation of communicative responsibility and execution of various communicative behaviors (as we have tested here) are social skills that could potentially improve the machine's interaction with the user. Additionally, providing the framework can encourage scholars to focus more on how meaning-making affects user's interaction with machines. Go et al.'s study (2020) proposed interactive technology acceptance model (iTAM) to study the machines that verbally interact with a user by examining the user's characteristics (e.g., self-efficacy and perceived enjoyment) and the machine's characteristics (e.g., type of AI robot and machine learning algorithm). Although the iTAM is created to understand machines that communicate with the users, it does not take the essence of interaction (i.e., meaning-making) into account. Therefore, CRT can potentially provide a theoretical framework that may further develop iTAM.

Although this study closely mirrors the original study that tested CRT by examining a navigation task (Aune et al., 2005), the findings from the two studies are not fully aligned. According to the theoretical reasoning and findings in Aune et al.'s study, we would expect participants to prefer general landmarks (i.e., reflecting less implicatures) when they believe that the navigation has more communicative responsibility and prefer location-specific landmarks (i.e., reflecting more implicatures) when they believe that they have more communicative responsibility. When the burden of meaning-making falls more to the navigation, it should use language that requires less inference-making. However, this study found that participants preferred location-specific landmarks to be used when they perceived the communicative responsibility to fall more on the machine. This may be because of the role and the function of a navigation system: an advanced driver assistance system that enhances driver comfort and convenience (Rahman et al., 2017). While the roles of an interactive machine are to retrieve information from a database and respond accordingly to the requested information (Go et al., 2020), people do not have the same obligation when giving directions to strangers they meet on the street. As machines are purposefully built to aid their users, the purpose may be more important than the context of communication. Additionally, HMC research suggests that people adjust their communication when talking with a machine. Gambino and Liu (2022) proposed that people use fewer complex words and sentences, and include more paraphrasing when talking to a machine compared to when talking to another person. Instead of studying the language of the users, this study examined the effects of the machine's language.

This study also contributes to TAM literature, especially regarding interactive technology. Continuous development and the variation in the extended versions indicates that TAM is useful and applicable to a wide range of technologies. However, it is also criticized for providing piecemeal knowledge. Even the recent renditions of TAM (e.g., Al Shamsi et al., 2022; Chocarro et al., 2021; Go et al., 2020; Sagnier et al., 2020; Wang et al., 2020) do not provide a coherent categorization and a solid theoretical framework for the precedents of perceived usefulness and ease of use. Consequently, the model may include factors that are no longer relevant or exclude factors that are crucial (Röcker, 2010). For instance, in Park et al.'s (2015) study of navigation system, they examined multiple external factors (e.g., perceived locational accuracy, satisfaction, perceived system reliability, and service quality) of TAM. They grouped these factors as the user's psychology. Following CRT, we recommend a trifurcation of external factors (i.e., user's perception, communicative behavior of the technology, and the context of interaction), which is highly relevant to technologies that are capable of engaging in communicative interaction. The results of our study demonstrates that the user's perceptions may interact with the communicative behavior of the navigation.

The salience of communicative responsibility and communicative behavior provides a roadmap to potentially improving interactive machines. Interactive machines include those that verbally interact with the user, retrieve information from a database, and respond to the user's request with accurate information (Go et al., 2020). This study suggests the importance of how to present the information to whom. For instance, a navigation system can utilize the user's data to determine if the user is likely to attribute more communicative responsibility to the navigation system. A user who frequently deviated from the recommended route and made unexpected detours is likely to expect the navigation to have a higher communicative responsibility. When this user has left their usual vicinity, the navigation may provide directions with location-specific information and additional information to clearly communicate the route. As for those users who have an aptitude for following the suggested route or finding faster alternatives, this kind of additional information and explication of directions may be less useful. Additionally, this also applies to other communicative machines. For instance, when using a voice-assistant reminder for managing schedules, a simple pop-up note with a gentle nudge may be enough for schedules that the user has created. However, for schedules that other users created (i.e., invitations to meetings), the voice assistant can call out the details of the schedule, such as the location, time, and a list of other attendees. Another example is a kiosk that is placed in restaurants and malls that assists people in ordering and purchasing products. Younger generations may be familiar with the kiosk. They will prefer a simple and fast interaction with the machine. However, for those users who are less familiar with such technology, the kiosk can additionally provide hands-on explanations of how to use the machine. This may mitigate the discomfort of using kiosks, which is more clearly evident in certain demographics (Na et al., 2021).

The current findings need to be interpreted with several limitations in mind. There are limitations to how the study was designed. The communicative responsibility was measured once at the end of the interaction. According to Kecskes and Zhang (2009), the evaluation of common ground is dynamic and constantly being updated as the communication progresses. People can adjust their communication by monitoring whether what they are saying violates the common ground or not (Horton & Keysar, 1996). Therefore, the communicative responsibility may change within the communication process. Future research can examine the dynamics of communication by using a cross-lagged panel model. Additionally, this study had participants imagine themselves driving while listening to a recording. The ecological validity of the study can be enhanced by utilizing driving-simulation games, such as the Truck Simulator series from SCS Software, and gaming steering wheel (e.g., Logitech G920 Driving Force Racing Wheel). Realistic games can provide an immersive task that is also easily controlled by the researchers. The more immersive experiment design may also introduce variance in the perceived ease of use because the difficulty of driving in the real world and in a simulated world is drastically different from imagination.

It is recommended for future researchers to further investigate the notion of common ground and the determinants of communicative responsibility. As shown in Figure 1, there are multiple communication contexts. This study investigated a specific niche: two different levels of common ground created in the context of driving. Technologies that are used for other purposes may bring additional dynamics to communicative responsibility. For instance, a user may attribute a large amount of communicative responsibility to health care chatbots, making the communication highly asymmetrical. In this case, variations in communicative behaviors should not focus on the degree of implicature but on how to enhance the user's inference-making experience.

Although mutual understanding is an essential aspect of CRT, this study has not examined to what degree the users perceived the communication to have fostered a mutual understanding. Considering how the user's perception of mutual understanding enhances the perceived utility of the machine and its performance (Stubbs et al., 2008), future research can either measure the degree of perceived mutual understanding or dive into examining its determinants and consequences. For instance, an explicated and redundant message may increase the perceived mutual understanding, but backfires in the efficiency of its performance to those that do not attribute much communicative responsibility to the machine. Additionally, nonverbal communication may affect the perceived level of mutual understanding (Alibali et al., 2013). For instance, the augmented head-up display (i.e., windshield augmented navigation) may be used only when the mutual understanding is substantially low, which could be determined by the level of frustration and confusion of the user. Therefore, instead of treating the augmented head-up display as all or nothing, the technology should estimate the level of common ground and visually show the route when the driver needs it, such as finding the exit of an unfamiliar road.

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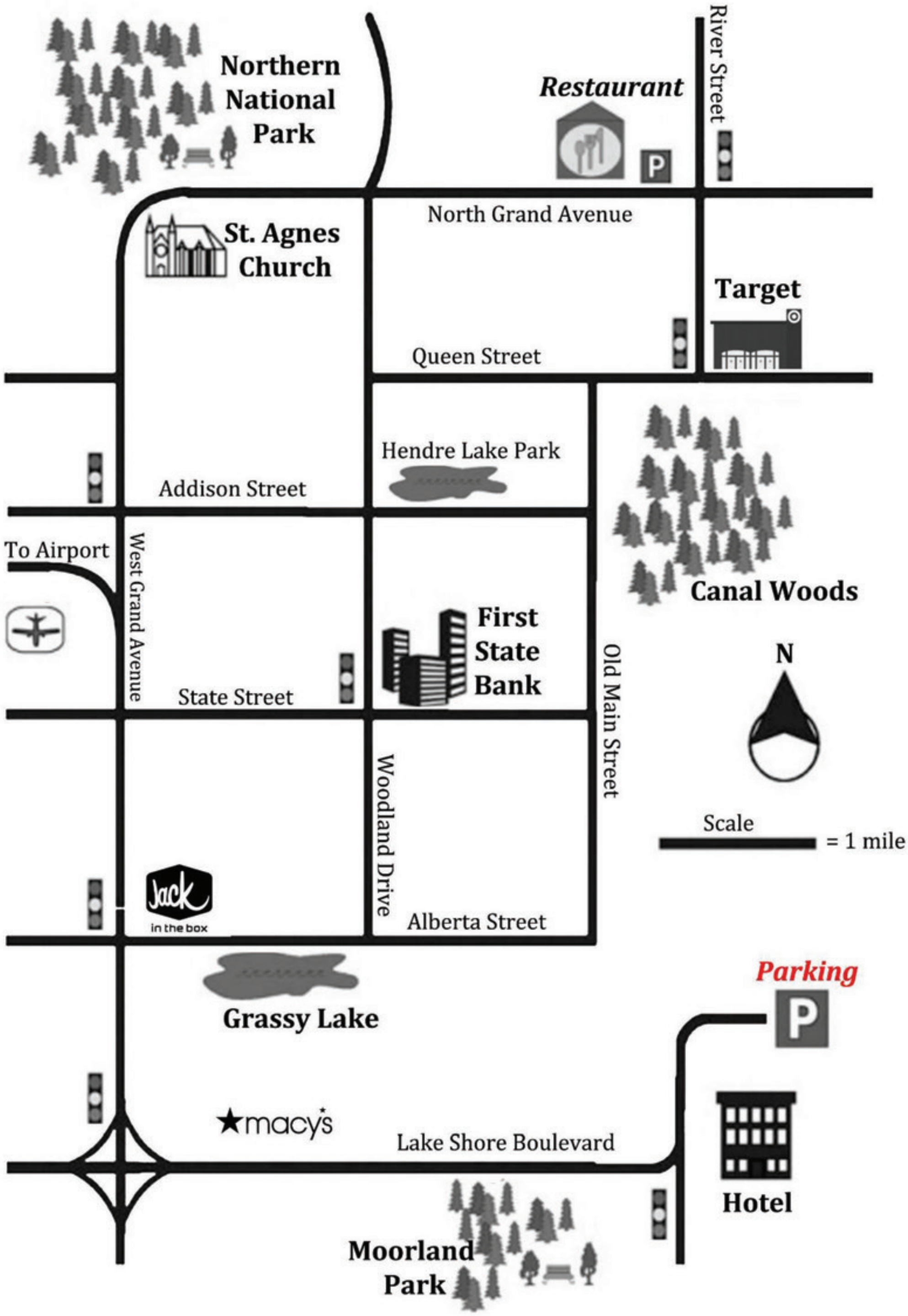
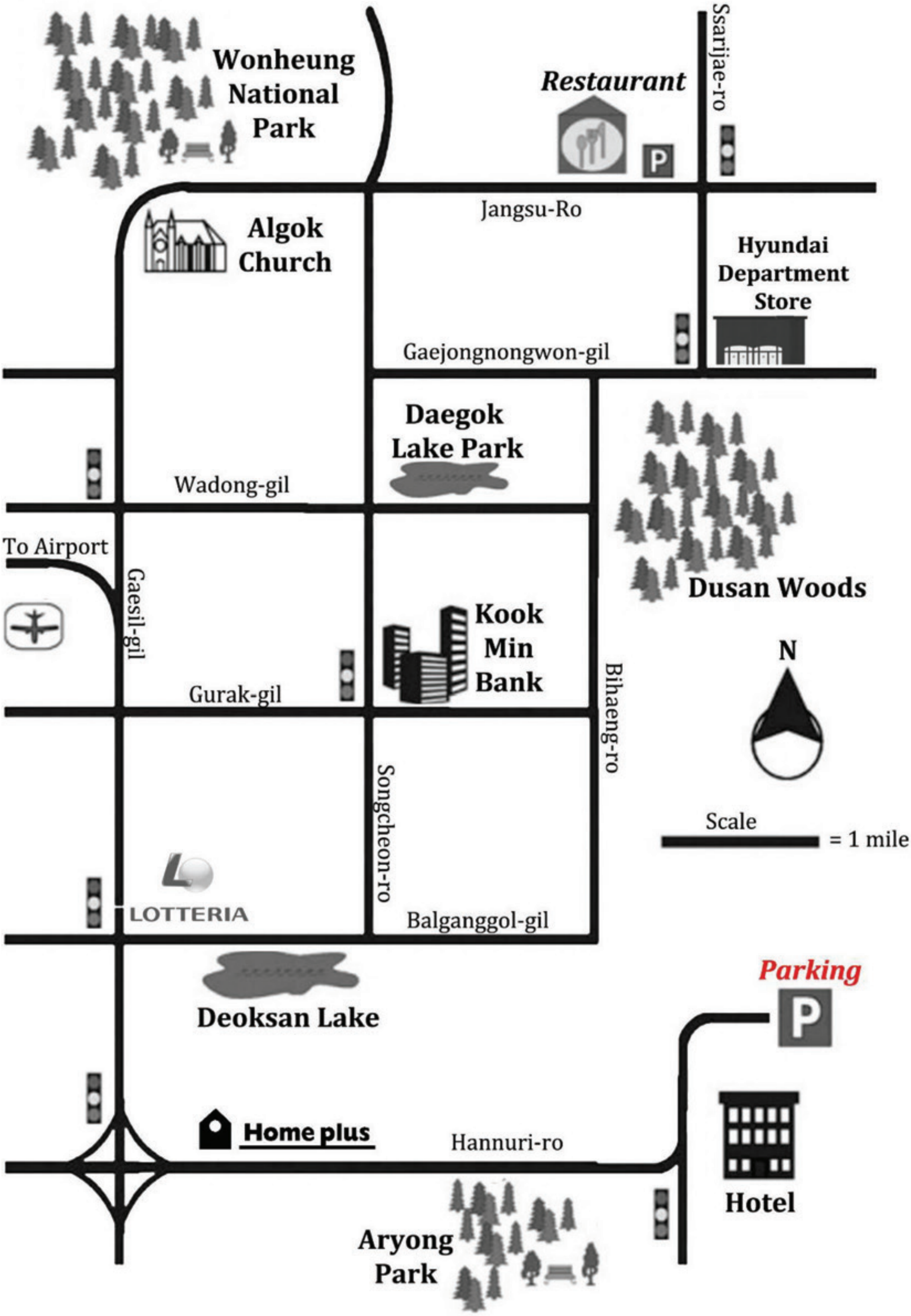
APPENDIX A The Overall Map of a Hypothetical City in USA



APPENDIX B The Overall Map of a Hypothetical City in South Korea



Appendix C Measurement Items

All the items below are measured with a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Items with an asterisk (*) are reverse coded.

Items for Manipulation Check

1.* The names of the natural landmarks (e.g., parks, lakes, woods) are unusual.
2. The names of the stores and brands are familiar to me.
3.* The names of the streets are unusual.

Items for Participant's Communicative Responsibility

1. Given this context, the responsibility for making sure that you understand the directions is mostly on you.
2. In this context, you have a much bigger responsibility for understanding how to get to the destination than the navigation system.
3. You are more responsible than the navigation system for making certain you understand the directions.
4. It is expected for you to make an extra effort to understand the directions.
5. It is appropriate, in this context, that you work harder to make certain that you understand the direction to the restaurant.

Items for the Navigation System's Communicative Responsibility

1. Given this context, the responsibility for making sure that you understand the directions is mostly on the navigation system.
2. Compared to you, the navigation system has a much bigger responsibility for helping you understand how to get to the destination.
3. The navigation system is more responsible than you for making certain you understand the directions.
4. It is expected for the navigation system to make an extra effort to help you understand the directions.
5. It is appropriate, in this context, that the navigation system work harder to make certain that you understand the direction to the restaurant.

Items for Perceived Ease of Use

1. I think that learning to operate the navigation system will be easy for me.
2. It will be easy to find my destination by using the navigation system.
3. Overall, I think that it is easy to use the navigation system.

Items for Perceived Usefulness

1. I believe that the navigation system can help me to save time.
2. I think that I can get the information about the destination using the navigation system.
3. Overall, I find the navigation system to be very useful.

Items for Behavioral Intention to Use the Navigation System

1. I will be willing to use the navigation system in the future.
2. I intend to use the navigation system in the near future.
3. I have it in my mind to use the navigation system in the future.