Louder As Closer
Voice Intensity Influences Distance Judgment in Telecommunication

Chao Zhang
August 2012
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Preface

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The majority of the work was done by approaching (or hunting, in my friend’s word) strangers in a library. Field experiment is my favorite methodology, but doing it for 3 months can be a horrible experience. “Excuse me” was possibly what I said the most during that time, more than 400 times perhaps. After a while, everyone in the library seemed to recognize me and I started to perceive everyone’s face as familiar. Besides my thesis work, I can even assure you answers to some more interesting questions, such as where and when do most students come to work, what is the percentage of females in TU/e, and what is the best excuse to refuse a nice guy’s request. Anyway, I do miss laboratory now.

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Chao Zhang
Eindhoven, August 2012
Summary

Judging the distance to other objects and people is of great importance for human functioning. Because of the lawful relationship between sound intensity and spatial distance, people use intensity as a primary cue for distance judgment in daily life (Zahorik, Brungart & Bronkhorst, 2005). However, telecommunication technology creates situations in which voice intensity bears no valid information of someone’s distance. In this thesis, we draw on embodiment theories and presence theories to understand how people respond in the new context.

As inspired by embodiment theories (Barsalou, 2008; Semin & Smith, 2008), we argued that the conceptual association between sound intensity and distance should remain functional in the absence of the concrete link. Moreover, according to presence theories (Lombard & Ditton, 1997), people may experience telecommunication as unmediated and utilize the intensity cue as they do in unmediated communication. Based on the two rationales, we hypnotized a “louder as closer” effect that people will judge someone to be closer if they hear a louder voice during telecommunication. Based on the presence rationale alone, we also hypothesized that the effect would be moderated by people’s use experience. Three empirical studies were designed to test the two hypotheses.

Study 1 provided initial support for the “louder as closer” effect. In a between-subject field experiment, participants received phone calls with a cell phone and judged the location of the caller on a map. As predicted, those who heard a louder voice judge the location to be closer than those who heard a softer voice. With a similar paradigm, Study 2 replicated the “louder as closer” effect with Skype software. Study 2 also revealed the moderation role of use experience – participants who used Skype more often demonstrated a stronger effect. In Study 3, we explored a potential boundary condition of the “louder as closer” effect. When participants had knowledge about someone’s location, intensity information was no longer used in the process of distance estimation.

To integrate our findings, we proposed a two-stage model for the mechanism underlying the “louder as closer” effect in telecommunication. In the first stage, intensity information is automatically transformed into distance information. In the second stage, technology salience and strength of presence determines the applicability of the distance information in people’s overt judgment. We also suggested directions for future research.
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Introduction

In everyday communication, people extensively experience the association between sound intensity and spatial distance. For example, during a lecture, people hear the speaker’s voice to be softer and softer if they move away from the stage. People also adjust their own voice level to fit the distance between the target person and themselves. Through repeated experience, sound intensity develops into a valid auditory cue for judging distance (Zahorik, Brungart & Bronkhorst, 2005). People tend to judge louder sound as closer and softer sound as farther away. However, people do not only communicate with others in their proximal space, but also remote ones through telecommunication. In the context of telecommunication, voice intensity of the target person offers no valid information about his or her location. During a phone call, the voice of someone from another country can be just as loud as the one from next door. Therefore, in such context, it seems irrational for people to judge someone’s distance based on voice intensity.

As inspired by embodiment theories (for overviews, see Barsalou, 2008, and Semin & Smith, 2008), recent research has shown that processing sensorimotor information affects associated abstract thought even when the concrete link between the two domains is contextually irrelevant (see e.g., IJzerman & Semin, 2009; Jostmann, Lakens & Schubert, 2009). Similarly, we argue that the conceptual association between sound intensity and spatial distance should remain functional even if telecommunication disassociates the concrete link. Furthermore, presence theories suggest that people cannot fully appreciate the mediated nature of media technology (for a review, see Lombard & Ditton, 1997). If such illusion of nonmediation applies to telecommunication, people should use voice intensity to judge distance as they do in unmediated communication.

Based on the above two rationales, there is an intriguing possibility that people will base their distance judgment on voice intensity in telecommunication even though the behavior is irrational. In the following introduction, we review ideas and empirical findings in both embodiment literature and presence literature. Then we propose two hypotheses for empirical testing. Our research effort sheds light on the representational nature of the intensity-distance association and on people’s cognitive model of telecommunication technology.
Sound intensity as an embodiment for distance judgment

Knowing the distance of objects in the environment is crucial for human survival. In this sense, the human auditory system is not just for hearing, but for perceiving distance and guiding actions in the three-dimensional space (cf. Warren, 1981; for a similar view on vision, see Proffitt, 2006). In the physical world, sound intensity decreases with increasing distance, obeying an inverse-square law in acoustic free-field – doubling of distance results in 6 dB loss in sound intensity. Because of this lawful relationship, sound intensity functions as a valid distance cue. Indeed, based on extensive research in auditory perception, sound intensity has been considered as the primary auditory cue used by people to perceive distance (cf. Zahorik et al., 2005). The overwhelming influence of intensity was best shown in an experiment by Litovsk and Clifton (1992), in which intensity was designed to mismatch the location of the sounding object in some trails. In those trails, participants still reported louder sound as closer and softer sound as farther away, despite that other auditory cues could inform them of the correct locations. Moreover, the utilization of this cue is developed at a very young age: children between 4-7 months old are able to discriminate variations in sound pressure level (Bull, Eilers & Oller, 1984) and use the variations for distance perception (Freiberg, Tually & Crassini, 2001).

So far we have described the importance of sound intensity as a distance cue when the concrete link is valid. In order to evaluate the situation in which the concrete link is dissociated, we need to analyze the intensity-distance association at the level of mental representation. Through prolonged co-experience of “loud” and “close”, and “soft” and “far”, the association between the experience of sound intensity\(^1\) and distance perception may develop from a concrete link to a conceptual association (cf. Lakoff & Johnson, 1980). Here, by conceptual association, we do not mean a semantic or linguistic association based on an amodal or disembodied view of human conceptual systems. Rather, we adhere to the theories of embodied cognition that conceptual systems are built from schematic representations of perceptual experience (Barsalou, 2008).

\(^1\)The experience, or perceptual quantity of sound intensity is referred as loudness in auditory perception research. However, although loudness is mainly determined by intensity, it is also influenced by other properties of sound, such as spectrum. Also, there is a debate that whether loudness judgment is actually based on distance perception (see e.g., Warren, 1962; Warren, 1981). In auditory perception literature, intensity is always used when describing its concrete link to distance. To keep a consistency, we also use the term intensity even when describing the conceptual association, although we mean the perceptual experience of sound intensity. For easier understanding, when describing dimensional feelings, we use the words loud and soft, rather than high (intensity) or low (intensity).
1999). In other words, perceptual experiences, such as sound intensity and distance, are schematized and stored as modality-specific symbols in long-term memory. Also, we accept the notion that distance perception is embodied (Proffitt, 2006). Compared with the perception of a single physical dimension, such as sound intensity, distance perception is more abstract and complex. The concept “distance” is perhaps learnt from an integration of multimodal information, including visual cues, auditory cues as well as action. Indeed, consistent with Proffitt (2006)’s notion, distance perception has been shown to be affected by people’s potentials to act in space (Proffitt, Stefanucci, Banton & Epstein, 2003; Witt, Proffitt & Epstein, 2004). Therefore, we suggest that people’s mental representation of someone’s distance also includes the perceptual information about how loud the voice is. As a result, processing intensity information can affect people’s mental simulation of spatial distance and thus be transformed into distance information. Accordingly, the distance will be judged as smaller if a louder voice is processed.

When a conceptual association is built between two domains through repeated co-experience, the concrete link is no longer required for them to influence each other. Such effects has been observed in numerous studies concerning abstract concept grounding (see e.g., Boroditsky & Ramscar, 2002; IJzerman & Semin, 2009; Jostmann et al., 2009). For example, because heavy objects have more important impacts on human infants than light objects, a conceptual association between the perceptual experience of weight and the abstract concept of importance is built throughout childhood. Later in life, even when the concrete link between weight and importance is irrelevant, weight information still affect people’s judgments of importance. As shown by Jostmann and his colleagues (2009), participants took questionnaires more seriously and invested more mental effort if they held a heavier compared with a lighter clipboard. Even when the origin of the conceptual association (i.e., the concrete link) is not clear, effects of conceptual overlap may be observed for different domains. For example, although the association between pitch height and spatial height has no clear perceptual basis, research has found that people represent the two concepts in a systematic way, with higher pitch corresponding to higher spatial location (see e.g., Pratt, 1930; Rusconi, Kwan, Giordano, Umiltà, & Butterworth, 2005).

Unlike the pairs of domains mentioned above, for sound intensity and spatial distance, the concrete link between them is always valid in the physical world. This actually makes it difficult
to demonstrate the intensity effect on distance judgment in the absence of the concrete link. One tentative evidence comes from apparent-distance judgment paradigm (see e.g., Petersen, 1990; Stevens & Guirao, 1962). In those experiments, participants were asked to judge the apparent distance of sounds varying in intensity. Unlike normal sound localization task, those participants knew that the sounds were always from the same location – a fixed loudspeaker or a headphone, but they were nonetheless able to scale distance onto intensity. In this paradigm, because the research interest was to obtain a quantitative relationship between intensity and distance judgment, participants were encouraged to assume the concrete link and to use intensity information. Telecommunication, on the other hand, provides an unusual context in which the concrete link between intensity and distance is obviously disassociated. Assuming the concrete link and using intensity information would be very irrational. Still, as analogous to the reviewed findings about other pairs of domains, if distance judgment is embodied in sound intensity, it should be influenced by the latter even without the concrete link.

Perceptual illusion of nonmediation in telecommunication

Mark Weiser (1991) made his famous claim that “the most profound technology are those that disappear” (p. 94). He expressed the idea that when information products are well-designed, they can eventually become indistinguishable from the environment and require little attention from their users. Although Weiser focused mainly on advocating ubiquitous computing, his vision implicitly suggested the possibility that people may not be fully aware of the technology itself when using media. More explicitly, many media researchers share the term presence\(^2\) to describe the phenomena that people fail to adequately acknowledge the nature of mediation in media technology, or in other words, they experience a perceptual illusion of nonmediation (for a review, see Lombard & Ditton, 1997). This illusion has been explained from an evolutionary perspective that human brain is not evolved in the media age so it cannot treat media in a completely different way from objects and people in the real world (Reeves & Nass, 1996). IJsselsteijn (2004) further specified the type of processes underlying presence phenomena.

\(^2\) In media research, the term presence has diverse conceptualizations through its history. In this thesis, we accept the broad definition by Lombard and Ditton (1997) and use the term as interchangeable with perceptual illusion of nonmediation. It should be noted that this definition is quite different from the term social presence in the book “The Social Psychology of Telecommunications” (Short, Williams & Christie, 1976), which emphasizes on the social salience of the target person.
According to him, although characteristics of media technology can be learned through higher level cognitive representations (also known as media schemata), people mainly utilize reflective rather than reflexive processes to distinguish between mediated and unmediated stimuli.

Observations and empirical evidences of the perceptual illusion of nonmediation are reported with many different media. For instance, people often express feelings such as “I felt I was in the world the television created” when watching television. Such illusionary experience of has been extensively measured by self-report (Lombard & Ditton, 1997). People also respond to pictorial representations in a similar way as they respond to real people. When the subjective distance between pictures and participants became smaller, they paid more attention, recalled more and displayed stronger physiological responses (Reeves, Lombard & Melwani, 1992). In teleoperation, the human operator may have the feeling of being in the remote environment rather than in the operation room (Minsky, 1980). In other words, they have the illusion of moving remote objects with their own hands if their actions and sensory feedback are contingent (cf. Loomis, 1992). In a similar vein, immersive virtual environment often makes its users to feel being in the virtual world it creates. Research has also shown that events that happen in virtual environment can be confused with real-life events in people’s memory (Shapiro & McDonald, 1992).

For this thesis, it is important to ask whether such perceptual illusion also applies to telecommunication. Although most modalities of telecommunication have lower perceptual qualities than media such as television and virtual environment, they enable real-time interactions. The property of real time and the interactivity are said to be factors that can enhance presence (Lombard & Ditton, 1997). Indeed, at the early adoption age of telephone, the AT&T advertised telephone as “the next best thing to being there” (Lombard & Ditton, 1997). Therefore, we argue that people may experience telecommunication as if it’s nonmediated. In other words, people will hear someone’s voice during telecommunication as if they are hearing it directly from the physical world. As a consequence, people will judge the distance of the target person based on voice intensity as they do in unmediated communication.

The notion of presence offers an additional prediction that the technology salience may determine the extent to which people utilize sound intensity as a distance cue in telecommunication. Lombard and Ditton (1997) considered the obtrusiveness of medium as a
factor that influences the strength of presence. When the medium becomes less salient (obtrusive), people pay less attention to the technology and the illusion of nonmediation is enhanced. Since the perceptual illusion of nonmediation is a prerequisite for intensity to have an influence on distance judgment, technology salience should moderate the strength of the influence. Moreover, technology salience is in turn influenced by the amount of use experience. With sufficient experience, technology demands less attention and awareness (cf. Weiser, 1991). Therefore, people with more experience with a certain type of telecommunication technology should be more likely to use sound intensity as a cue in judging distance.

**The current studies**

We have reviewed two rationale that support the possibility that people still use sound intensity to judge distance in telecommunication. The two rationales assume different underlying mechanisms of the same phenomenon. Under the theories of embodied cognition, the conceptual association between intensity and distance remains functional even when telecommunication disassociates the concrete link. According to the notion of presence, people keep using the concrete link between intensity and distance because they treat telecommunication as largely the same with unmediated communication.

Due to the limited scope of the thesis, our primary goal is not to resolve the plausibleness of the two different mechanisms. Rather, we take the two perspectives together to hypothesize that in telecommunication sound intensity will still influence people’s distance judgment of the target person. People who hear a louder voice will judge the target person to be physically closer, while people who hear a softer voice will judge the person to be physically farther away (hereafter referred to as “louder as closer” hypothesis/effect). Based on the presence perspective alone, we also expect that amount of use experience moderates the “louder as closer” effect. Specifically, experienced users should have a stronger tendency to use intensity as a cue than novice users.

We will report three empirical studies that test the two hypotheses. In Study 1, we test the “louder as closer” hypothesis in the context of telecommunication using a cell phone. In Study 2, we try to replicate the effect with a different telecommunication tool – Skype software. We also examine the potential moderation role of use experience in the same study. In Study 3, we test
the hypothesis in a different paradigm to explore a potential boundary condition of the “louder as closer” effect.
Voice Intensity Influences Distance Judgment in Telecommunication

Study 1

Study 1 is aimed to test the “louder as closer” hypothesis with cell phone. We chose to use cell phone because it is perhaps the most frequently used telecommunication device. The sufficient use experience, combined with the small size of device and the simplicity of making phone call, should result a very low technology salience and increase the chance that people experience the nonmediation illusion (cf. Lombard & Ditton, 1997; Weiser, 1991). Thus, cell phone provides us the safest choice for revealing the effect. We predicted that when participants heard a louder compared to softer voice over a cell phone, they would judge the location of the caller to be closer.

To make the experiment to be both rigorous and meaningful, we took a few things into account. First, we tested the effect in a very realistic setting. Participants were approached during their daily activities and received normal phone call before making distance judgment. Secondly, unlike the apparent-distance judgment paradigm (Petersen, 1990; Stevens & Guirao, 1962), we used a between-subject design so that participants only hear one level of the voice intensity. This treatment reduced the likelihood of demand characteristic and ruled out the possibility of a comparison-based effect. Thirdly, we used a double-blind design so the experimenter was not aware of participants’ conditions. The assignment of conditions was based on a predefined random list only known to a separate research assistant, who also helped with making phone calls. All these considerations also applied to Study 2 and Study 3.

Method

Participants and design

Forty-four people (16 females) voluntarily participated in the experiment. Participants’ ages were not noted down, but most of them were undergraduate or graduate students at Eindhoven University of Technology (TU/e). Participants were randomly assigned to either a softer voice condition or a louder voice condition in a between-subject design.

Material and setting

The field experiment was performed in the main hall of the Central Library at TU/e. Participants were approached at random and were asked to listen to a sample of English speech
on a cell phone (Samsung SCG-C128) with either a softer (41 dB) or a louder (52 dB) voice\textsuperscript{3}. Participants were standing while answering the calls. They were asked to hold the cell phone close to their ears to reduce the variations in intensity caused by the variations of the distance between their ears and the phone. The duration of the stimulus was 30 seconds.

**Dependent measures**

Distance judgment was measured through a virtual localization task\textsuperscript{4}. An abstraction of the TU/e campus map was used in this task (see Figure 1). After the phone call, participants were shown the map and were asked to guess the location of the caller by marking it on the abstracted map. We used the virtual localization task rather than direct verbal or graphical distance estimation because the task is more analogous to sound localization in the physical world and it is more realistic. Measuring distance judgment in this way also avoided priming participants with the concept of distance.

![Figure 1. The abstraction of the TU/e campus map used in Study 1 (the star denotes the point where the participant is located (i.e., the Central Library)](image)

\textsuperscript{3} Average sound pressure level during the length of the stimulus was measured with a sound level meter. The same method applied to Study 2 and Study 3

\textsuperscript{4} This task actually consists of a distance judgment and an orientation judgment. Since we assume that sound intensity should not affect orientation judgment, by decomposing the distance component, we should be able to show the “louder as closer” effect.
An additional short questionnaire was used for manipulation check and to evaluate alternative explanations. Five questions were asked: (1) How loud was the speech? (2) How was the quality of the call? (3) How clearly could you hear the speech? (4) How much did you like the speech? and (5) To what extent are you familiar with the speech? All questions were rated on 1 to 7 scales.

Procedure

An experimenter approached students and asked them to help in the Central Library at TU/e. The experiment was described as a study about sound quality of phone calls. Participants were told that they were going to receive a phone call from a research assistant who was described as being somewhere in the campus. Then the experimenter initiated a call to the research assistant, asking him to call back. Participants answered the call by themselves and listened to the speech sample for 30 seconds. Afterwards, they were shown the abstracted map and were asked to mark the location of the caller based on their intuition. Remaining questions were filled in afterwards. They were debriefed and thanked at the end.

Results

The manipulation check showed that participants in the louder condition indeed perceived the voice as louder than those in the softer condition ($M_{\text{softer}} = 2.73$, $SD_{\text{softer}} = 1.08$; $M_{\text{louder}} = 4.00$, $SD_{\text{louder}} = 1.38$; $t(42) = -3.41$, $p = .001$).

The raw data of virtual localization task is shown in Figure 2. The distance estimation was computed by measuring the Euclidean distance between participants’ marked locations and the star (their location at the Central Library). Two participant’s judgment data were excluded because they guessed the location based on either the content of the speech\(^5\) or his knowledge about the experimenter. As expected, participants marked the caller’s location to be closer to themselves if they were in the louder condition than if they were in the softer condition ($M_{\text{softer}} = 9.93$, $SD_{\text{softer}} = 3.61$; $M_{\text{louder}} = 7.34$, $SD_{\text{louder}} = 3.77$; $t(40) = 2.27$, $p = .029$; Cohen’s $d = 0.70$)\(^6\). The mean difference was 2.59 centimeters on the map, which corresponded to 170.62 meters in

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\(^5\) The English speech has something to do with train ride, so this participant judged the location to be the train station.

\(^6\) With those two data points included, the “louder as closer” effect was marginally significant ($t(42) = 1.82$, $p = .075$).
the physical scale. A weak negative correlation between perceived loudness and distance judgment was also found, although it did not reach a significant level ($r = -0.146, n.s.$)

**Figure 2.** The raw data of the virtual localization task in Study 1.

There was a marginally significant difference in processing fluency (i.e., how clearly participants could hear the speech) between the two conditions, indicating that participants also felt the speech to be clearer if they were in the louder condition than if they were in the softer condition ($M_{\text{softer}} = 2.41, SD_{\text{softer}} = 1.26; M_{\text{louder}} = 3.05, SD_{\text{louder}} = 0.95; t(40) = -1.89, p = .065$). However, the correlation between fluency and distance estimation was almost zero ($p = -0.007, n.s.$) and adding fluency as a covariate did not change the results ($F(1, 41) = 4.85, p = .034, \eta^2 = .11$). There were no significant differences between the two conditions in terms of phone call quality, liking of the speech and familiarity with the speech.

**Discussion**

Study 1 provides initial support for the “louder as closer” hypothesis. When participants heard the voice of a phone call louder, they perceive the caller to be closer. Remarkably, the effects was found in a very realistic setting with a moderately realistic campus map. Participants’

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7 The background on this map is only for illustration purpose. The map used in the study was blank as shown in Figure 1. The same applies to figures about Study 2.
task was not to describe how far they feel the caller was from them but to guess the physical location of the caller on the map. Although people had various reasons for their guesses (e.g., where cars come in), they nonetheless incorporated sound intensity as a distance cue.

There is one alternative explanation for the revealed effect. Participants in the louder condition also heard the speech more clearly than those in the softer condition. The increased processing fluency may account for the “louder as closer” effect. As shown by Alter and Oppenheimer (2008), participants estimated the distance between their living place and several other American cities to be smaller either when they saw the cities’ names printed in a more legible font (perceptual fluency, Study 1a) or when they encountered the names in an unrelated earlier task (conceptual fluency, Study 2a). However, as the results have shown, although fluency seemed to differ between the two conditions, it did not correlate with the distance estimation and an ANCOVA did not change the significant effect of intensity condition. Therefore, we believe that the fluency-based explanation is not plausible.
Study 2

The primary goal of Study 2 was to replicate the “louder as closer” effect found in Study 1 with a different type of telecommunication tool, namely Skype software. Despite its similar function, Skype can be quite different from cell phone in terms of people’s cognitive model of the technology. First of all, when using Skype normally, you need to face a PC or notebook, which is much more salient than a small cell phone. The salience or obtrusiveness of technology may reduce the likelihood that people perceive it as unmediated (cf. Lombard & Ditton, 1997). In addition, volume control is arguably more salient on a PC or a notebook than on a cell phone. Adjusting volume is a routine task when using Skype but not when using a cell phone. Thus, people may be more likely to attribute the intensity change of voice to the technical system rather than to the target person, which may diminish or entirely nullify the effect. Moreover, cell phone and Skype users typically have different levels of mobility. The static way of using Skype may make people to be less sensitive to distance change or even not to think about someone as being located in the physical space. For example, “where are you” is a common question people ask during calls using a cell phone but not during Skype calls. Therefore, if the “louder and closer” effect also holds for Skype call, Study 2 will testify to the robustness and generability of the original finding.

Another goal of Study 2 was to explore the moderation role of use experience in the “louder and closer” effect. Unlike the case of cell phone, not everyone has experience with Skype software. Indeed, at least for the majority of the Dutch population, the use of Skype for making calls is limited to an average of a few times each year (Van Deursen & Van Dijk, 2011). This means that participants in our experiment sample should vary to a sufficient extent on their amount of experience with Skype. As we discussed, increased use experience should result in a decreased technology salience, which in turn leads to an enhanced feeling of nonmediation. Therefore, we expected that use experience moderated the “louder as closer” effect. Specifically, participants who used Skype more often should be more likely to take intensity as a cue for distance judgment.

Finally, there were several methodological advantages of using Skype software. One limitation of the Study 1 was that the distance between the cell phone and participants’ ears was not fully controlled, despite the instruction to put the phone close to their ears. Using a
headphone would make the distance constant. Also, the ambient sound pressure level cannot be fully controlled in a field setting. A high-quality headphone minimized this problem. Finally, with the new technical setting, the sound quality during the call was improved in both softer and louder conditions (in Study 1, the scores of quality were lower than the mid-point of the scale in both conditions).

**Method**

*Participants and design*

Sixty-seven people (20 females) voluntarily participated in the experiment, with a mean age of 22.3. All participants were Dutch speakers and most of them were students at TU/e. The experiment was again a between-subject design, with participants listening to either heard a softer or a louder voice during the call.

*Material and setting*

The experiment was again conducted in the Central Library of TU/e. This time, we used a normal setting of Skype call – sitting on a chair, wearing a headphone and using a notebook on a table to make a Skype call. To make the call more realistic, a pre-recorded speech in Dutch was presented. Participants were made to believe that the speech was an experiment introduction by the research assistant (the caller) in real time. The speech was either in a softer (43 dB) or a louder (63 dB) voice. The duration of the stimulus was 22 seconds.

*Dependent measures*

The same virtual localization task was used as in Study 1. The additional questions about the call were modified to fit the ostensible online instruction: (1) How loud was the talk? (2) How was the quality of the call? (3) How clearly could you hear the voice? (4) How was your impression of my colleague’s talk in general? (5) To what extent did you feel the voice to be familiar? Two more questions were added to assess participants’ past experience with Skype: (1) How frequently do you use Skype (or similar software) to make phone call? (2) How do you like

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8 The final sound pressure levels (SPL) in Study 2 were decide after a pilot test of 16 participants. The SPLs in the pilot were 63 dB (louder) and 48 dB (softer). Because the perceived loudness was not significant different between the two conditions, for the formal experiment, the SPL in the softer condition was reduced to 43 dB.
your experience with Skype (or similar software) in general? All questions were measured on 7-point scales.

**Procedure**

The procedure was identical with the one in Study 1, except for the change of technical setting described above. Since the voice on the phone was actually pre-recorded, participants were asked not to speak but only listen during the call in order to reduce suspicion. This instruction was: “for the purpose of experiment control, my colleague will try to talk to everyone in exactly the same way, so there will be no real interaction. You don’t need to speak, but just listen”.

**Results**

**Manipulation check**

One participant was excluded because the stimulus for her was not identical as for the other participants (the call dropped mid-stimulus because of an internet connection problem). The manipulation check showed that participants in the louder condition indeed perceived the voice as louder than those in the softer condition ($M_{\text{softer}} = 2.82, SD_{\text{softer}} = 1.04; M_{\text{louder}} = 5.36, SD_{\text{louder}} = 0.70; t (64) = -11.64, p < .001$).

**Main prediction**

The raw data of the virtual localization task are shown in Figure 3. The dependent variable, distance judgment was computed from the raw data in the same manner as in Study 1. Before statistical analysis, three participants were further excluded based on pre-defined criteria$^9$. Two of them demonstrated strong suspicions that the voice was not in real time but pre-recorded. The other one judged the distance based on his knowledge about the experimenter.

Since the direction of effect was revealed in Study 1, a one-tail $t$-test was performed to test the effect of voice intensity on distance judgment. As expected, participants in the louder condition judged their distance to the target person to be smaller than those in the softer condition ($M_{\text{softer}} = 9.15, SD_{\text{softer}} = 3.03; M_{\text{louder}} = 7.80, SD_{\text{louder}} = 3.32; t (61) = 1.680, p = .049$; $^9$ With those three data points included, the general pattern of the results did not change.
Cohen’s $d = 0.42$). Meanwhile, perceived loudness had a marginally negative correlation with distance judgment ($r = -.220, p = .083$). Judged distance was also negatively correlated with both sound quality ($r = -.371, p = .003$) and fluency ($r = -.368, p = .003$). Fluency also significantly differed between the two conditions ($t (61) = -3.40, p = .001$). By adding fluency as a covariate, the effect of intensity condition on distance judgment was rendered non-significant ($F (1, 62) = 0.335, p = .28$ (one-tail)).

**Figure 3.** The raw data of the virtual localization task in Study 2

**Use frequency as a moderator**

To test if the strength of the “louder as closer” effect on distance was moderated by participants’ Skype use frequency, we performed a moderated linear regression analysis. The three predictors were: the loudness condition, the use frequency (centered) and condition by frequency. Table 1 presents the results of the moderated regression analysis. Figure 4 shows the regression lines for three different levels of the moderator. The results clearly suggested a moderation role of Skype-usage frequency: the negative relationship between voice intensity and distance judgment became stronger as participants used Skype more often.

In addition, we performed another three moderated linear regression analyses, with perceived loudness, sound quality and fluency (all centered) as predictor in each analysis. The dependent variable was always distance judgment and the moderator was always use frequency.
Results of the moderated regression analysis are shown in Table 2-4. As the results revealed, for participants who used Skype more often, the negative correlation between perceived loudness and distance judgment was stronger. On the contrary, use frequency did not moderate the correlation between sound quality and distance judgment nor the correlation between fluency and distance judgment.

Table 1

*Results of the moderated linear regression (intensity condition)*

<table>
<thead>
<tr>
<th>Predictors</th>
<th>$B$</th>
<th>$t$-value</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity condition</td>
<td>-1.352</td>
<td>-1.750</td>
<td>.085</td>
</tr>
<tr>
<td>Use frequency</td>
<td>0.426</td>
<td>1.235</td>
<td>.222</td>
</tr>
<tr>
<td>Condition by frequency</td>
<td>-1.065</td>
<td>-2.365</td>
<td>.021</td>
</tr>
</tbody>
</table>

$R^2 = .137$

*Figure 4.* Regression lines for three different levels of moderators
Table 2

Results of the moderated linear regression (perceived loudness)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>$B$</th>
<th>$t$-value</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived loudness</td>
<td>-0.532</td>
<td>-2.101</td>
<td>.040</td>
</tr>
<tr>
<td>Use frequency</td>
<td>-0.113</td>
<td>-0.494</td>
<td>.623</td>
</tr>
<tr>
<td>Loudness by frequency</td>
<td>-0.348</td>
<td>-2.261</td>
<td>.027</td>
</tr>
</tbody>
</table>

$R^2 = .138$

Table 3

Results of the moderated linear regression (sound quality)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>$B$</th>
<th>$t$-value</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound quality</td>
<td>-0.768</td>
<td>-2.891</td>
<td>.005</td>
</tr>
<tr>
<td>Use frequency</td>
<td>-0.038</td>
<td>-0.166</td>
<td>.868</td>
</tr>
<tr>
<td>Quality by frequency</td>
<td>0.202</td>
<td>1.195</td>
<td>.237</td>
</tr>
</tbody>
</table>

$R^2 = .160$

Table 4

Results of the moderated linear regression (fluency)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>$B$</th>
<th>$t$-value</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluency</td>
<td>-0.768</td>
<td>-3.009</td>
<td>.004</td>
</tr>
<tr>
<td>Use frequency</td>
<td>-0.067</td>
<td>-0.269</td>
<td>.789</td>
</tr>
<tr>
<td>Fluency by frequency</td>
<td>-0.094</td>
<td>-0.641</td>
<td>.524</td>
</tr>
</tbody>
</table>

$R^2 = .147$

Compare users with non-users

As the moderation analysis suggested, the strength of the “louder as closer” effect differed in terms of how much experience participants had with Skype call. Therefore, it seemed meaningful to divide the sample into users and non-users and check the potential differences between the results of the two groups. Testing the hypothesis among users separately also facilitated a comparison with the results of Study 1, in which every participant was user of cell
phone. Use frequency was measured on a 7-point scale, so we took a conservative criterion by assuming participants who rated 1 to be non-users and those who rated higher than 1 to be users. This division resulted in 39 users (21 in the softer condition, 18 in the louder condition) and 24 non-users (11 in the softer condition, 13 in the louder condition).

The raw data of users’ marked locations is depicted in Figure 5. As expected, there was a stronger effect of intensity condition on distance judgment among Skype users than among all participants ($M_{\text{softer}} = 9.54$, $SD_{\text{softer}} = 2.78$; $M_{\text{louder}} = 6.67$, $SD_{\text{louder}} = 2.48$; $t(37) = 3.389$, one-tail $p = .001$; Cohen’s $d = 1.09$). The mean difference between the two conditions was 2.88 centimeters on the map, which corresponded to 189.47 meters in the physical scale (comparable to the results of Study 1, which yielded a difference 2.59 cm, corresponding to 170.62 meters). This effect was accompanied by a significant negative correlation between perceived loudness and distance judgment ($r = -.533$, $p < .001$). As a potential confound, perceived fluency was significantly different between the two conditions ($t(37) = -3.29$, $p = .002$) and it correlated with distance judgment ($r = -.434$, $p = .006$). However, the influence of intensity remained significant even when adding fluency as a covariate ($F(1, 36) = 5.160$, one-tail $p = .015$, $\eta^2 = .10$), which testified to the unique contribution of intensity as an independent factor. Unlike fluency, sound quality did not differ between the two conditions nor did it correlate with distance judgment.

![Figure 5. The raw data of the virtual localization task among users](image_url)
Intriguingly, the results of non-users demonstrated an exactly opposite pattern. First of all, the main prediction was not supported among non-users. Their distance judgments did not differ significantly between the two conditions ($M_{\text{softer}} = 8.39$, $SD_{\text{softer}} = 3.48$; $M_{\text{louder}} = 9.38$, $SD_{\text{louder}} = 3.77$; $t(22) = -0.661$, $p = .258$ (one-tail)). Moreover, this result was further consolidated by a two-way ANOVA (see Figure 6). Despite a lack of main effects, there was a significant interaction between intensity condition and participant group (user/non-user) ($F(1,59) = 5.908$, $p = .018$, $\eta^2 = .086$). Finally, correlation patterns of non-users were opposite to those of users. As the quality of the call get worst, non-user participants judged the location of the caller to be further away ($r = -0.620$, $p = .001$). On the contrary, perceived loudness and fluency did not correlate with distance judgment.

![Figure 6](image.png)

*Figure 6. Results of ANOVA with intensity condition and participant group as predictors*

**Debriefing**

During the debriefing, participants were explicitly asked whether their thought their distance judgments were influenced by the Skype call. Fifteen participants mentioned that the quality of the call might have influenced their answer. There were only 4 participants who suspected the association between sound intensity and distance. Importantly, excluding these 4 participants did not change the overall pattern of the results to any meaningful extent.
Discussion

Study 2 replicated the “louder as closer” effect found in Study 1, with a different type of telecommunication technology. Despite the differences between Skype and cell phone, the influence of sound intensity remains robust and strong. The influence of intensity was also found to be moderated by participants’ frequency of using Skype. Those who use Skype more often were more likely to use sound intensity to judge the location of the target person. This result is in line with the notion that with sufficient experience, technology becomes less salient and the nonmediation illusion becomes stronger (cf. Lombard & Ditton, 1997; Weiser, 1991). There was also a substantial difference between Skype users and non-users. For non-users, it was mainly the sound quality of the call that affected their distance judgment. The strong belief that the quality of Skype call should decrease with increasing distance may actually override any potential influence of intensity. For the users, they are more likely to be aware of the fact that, under normal network operation, the quality does not depend on distance – at least not for a small range such as the TU/e campus. As shown by moderation analysis, however, further increasing experience did not reduce the influence of sound quality among users, but still enhanced both the effect of intensity condition and the negative correlation between perceived loudness and distance, which warranted the technology salience explanation. Finally, as in Study 1, although it was difficult to fully eliminate fluency as a confound, intensity had its unique and substantial influence on distance judgment.
Study 3

In previous two studies, evidence has been obtained that people take intensity as a cue for distance judgment during telecommunication. The “louder as closer” effect was found in two different and realistic daily life contexts: participants received a phone call from, or made a Skype call to someone, and then were asked to guess the location of that person. It is worthy to note, however, participants in the two experiments knew nothing about the target person’s location and thus had very limited basis for their judgments. It is analogous to an unmediated situation where people hear a sound but do not know the location of the source, they utilize sound intensity as a cue for localization. However, in some other cases, people may know the location of the sound, but its exact position on the map and the numerical distance to the location are still uncertain. Two make a better illustration, let us consider two examples of the new case in unmediated and mediated situations respectively. The unmediated situation can be described as the following: when a student listens to a teacher from a certain location in the classroom, the student must know where the teacher is but he or she is unsure about the exact distance to the teacher. Then it is possible that if the teacher raises the voice, the student may judge the distance to be smaller. The mediated case is alike: when people Skype-chat with their friends who live in another country, their estimations of the distance to that country may be affected by the intensity of their friends’ voices.

To our best knowledge, unlike the well-established literature of sound intensity as an auditory distance cue for localization (Zahorik et al., 2005), there is no empirical evidence of such an effect on distance estimation even in unmediated context. It is unknown whether intensity information will also be used in the processes of specifying position and giving numerical distance estimation. In Study 3, we test this possibility and check if knowledge about the target person’s location is a boundary condition of the “louder and closer” effect.

Method

Participants and design

Seventy-five people (23 females) voluntarily participated in the experiment. Most of them were students at TU/e and the mean age was 24. Participants were randomly assigned to one of the three conditions. Two groups of people received phone calls, listening to either a softer or a
louder voice. The third condition was a control condition which assessed participants’ distance estimations without receiving any phone call.

**Material and setting**

The location and setting of the experiment was the same as in Study 1. The sound material was a different but similar sample of English speech, played with a softer (47 dB) or a louder voice (56 dB). The duration of the stimulus was 1 minute.

**Dependent measures**

Distance estimation between the Central Library of TU/e and St. Catharina's Church (a landmark building in Eindhoven) was used as the dependent variable. The estimation was measured both graphically and numerically. Participants were first asked to mark the location of the church on an abstract map, with the size of the campus as a reference of magnitude (see Figure 7). After that, they were asked to a numerical estimation in meters for the Euclidean distance between the two locations.

As in the previous two studies, some aspects of the phone call were measured, including perceived loudness, sound quality, fluency and familiarity to the speech. The final three questions concerned with the church: “How often do you visit or pass by the St. Catharina's Church?”, “How much do you like the St. Catharina's Church?”, and “To what extent are you familiar with the church?”. All questions were rated on 1-7 scales.

**Procedure**

For the softer and louder conditions, the procedure was very similar to Study 1. The experimenter told participants that the project aimed to test phone call quality at several different locations in Eindhoven and his colleague was currently in the St. Catharina's Church to test the quality there. After the brief instruction, participants received the phone call and listened to a sample of English speech, which was supposed to be played live in the church, for 1 minute. Afterwards, they gave their distance estimation first on the map, then in meters and they subsequently filled in additional questions. For those in the control condition, the experiment was presented as a survey about the St. Catharina's Church. Participants in the control condition filled in a questionnaire which was identical to the one used in the two experimental conditions,
except that the questions about the call were excluded. All participants were debriefed and thanked at the very end.

Results

Manipulation check

The manipulation check confirmed that participants in the louder condition perceived the voice of the speech to be louder than those in the softer condition ($M_{softer} = 2.80, SD_{softer} = 0.91$; $M_{louder} = 4.40, SD_{louder} = 1.00$; $t (48) = -5.91, p < .0001$). No reliable differences in other aspects of the call (quality, fluency, familiarity) were found.
Figure 8. The raw data of the graphical measure (additional information was added for illustration purpose)

**Graphical measure**

Surprisingly, there was no correlation between the graphical and the numerical estimations of the distance between the Central Library and the church \((r = -0.027)\). This almost zero-correlation implies that the graphical and numerical estimations measured different mental processes. Therefore, graphical and numerical measures were analyzed separately.

For the graphical measures, the raw data are shown in Figure 8. Distance estimation was computed from the raw data in the same manner as in the previous two studies. A one-way ANOVA revealed that there was no significant difference between the three conditions in terms of graphical distance estimation \((M_{\text{no call}} = 9.83, SD_{\text{no call}} = 2.32; M_{\text{softer}} = 9.96, SD_{\text{softer}} = 2.13; M_{\text{louder}} = 10.00, SD_{\text{louder}} = 2.23; F(2, 72) = 0.038, p = .963)\). Therefore, the graphical measure
provided no evidence for the main hypothesis. It was interesting to note that participants in all three conditions significantly overshooted the correct locations as revealed by one sample *t*-tests (all *p* < .001).

![Figure 9. Numerical estimation of the distance (correct answer indicated by the red dash line)](image)

**Numerical measure**

The distribution of the numerical estimation was largely skewed to the lower end, so we transformed the raw data using the square-root method. For the clarity of interpretation, the descriptive statistics are still shown in the unit of the raw data (see Figure 9). A one-way ANOVA was performed to test the main hypothesis. The results revealed no significant difference (*F*(2, 72) = 0.184, *p* = .832) in distance estimation among the three conditions: participants estimated the distance to be more or less the same, irrespective of whether they were in control (*M*<sub>no call</sub> = 1636, *SD*<sub>no call</sub> = 1069), softer (*M*<sub>softer</sub> = 1526, *SD*<sub>softer</sub> = 719) or louder (*M*<sub>louder</sub> = 1494, *SD*<sub>louder</sub> = 956) condition. As with the graphical measure, participants in all three conditions significantly overestimated the distance as revealed by one sample *t*-tests (all *p* < .05).

There was a significant negative correlation between familiarity with the church and the square-root transformed numerical distance estimation (*r* = -.260, *p* = .024). At first glance, this seemed to indicate a relationship between social distance and spatial distance – participants who felt more socially connected to a place also represented it to be spatially closer (in line with CLT,
for a review see Trope & Liberman, 2010). However, these results were probably caused by two accidental facts: (1) Participants made few errors (absolute differences between estimations and the correct answer, also square-root transformed) if they were more familiar with the church ($r = -.230, p = .047$); (2) In general errors were overshoots.

**Discussion**

Overall, Study 3 failed to replicate the effect of intensity on distance when using a different dependent measure – estimating distance to a known location. For both graphical and numerical measures, participants’ estimations of the distance between where they were and the St. Catharina's Church were virtually the same in the no-call, the softer and the louder condition. Nonetheless, Study 3 suggest a boundary condition of the “louder as closer” effect. It could be that the effect is limited to those cases when people need to localize the target person with intensity being one of the limited information. When the location is known, then the subsequent mental processes of graphical and numerical distance estimation are resistant to the influence of sound intensity.
General discussion

People spend more and more time communicate with remote others through telecommunication technology. In such context, the important concrete link between sound intensity and spatial distance is disassociated. In the opening of this thesis, we asked an intriguing question: do people still use sound intensity as a distance cue in telecommunication? Based on rationales from embodied cognition and presence research, we proposed two hypotheses: (1) In telecommunication, people also judge the target person as closer if they hear a louder voice than a softer voice; (2) This effect will be stronger for those who have more experience with the technology. Three empirical studies were performed to test the two hypotheses.

The “louder as closer” effect

Study 1 and Study 2 both provide evidence for the “louder as closer” effect with two different telecommunication technologies, namely cell phone and Skype software. Regardless of whether participants received a phone call via cell phone or via Skype, if they heard a louder voice, they tended to judge the location of the target person to be closer. In addition to the technology specifics, the loudness effect is robust across two other aspects: (1) In Study 1, participants listened to the sound from the loudspeaker of a cell phone, while in Study 2, they listened through a headphone; (2) The sound material was a sample of English speech in Study 1 but an ostensible on-line instruction in Dutch in Study 2. Both studies were conducted in a double-blind fashion (i.e., neither the participant nor the experimenter were aware which condition the participant was assigned to) and both studies utilized a between-subject design. This rules out the likelihood of demand characteristics as an explanation for the results. In general, the “louder as closer” effect seems to operate outside of people’s awareness. Most participants did not believe their judgments would be irrationally influenced by voice intensity.

In both studies, as the loudness of the sound increased, participants also perceived the sound to be clearer. The increase in fluency may provide an alternative explanation for our finding (cf. Alter & Oppenheimer, 2008). In Study 1, although fluency seemed to differ between the two conditions, it did not correlate with distance judgment. Also, adding fluency as covariate in ANCOVA did not change the result. In Study 2, fluency differed significantly between the two conditions and correlated with distance judgments, but again it did not change the significant
influence of sound intensity in ANCOVA. Therefore, it is safe to say that intensity has its unique effect on people’s distance judgments. Fluency may or may not have its contribution in this context. This possibility can be further investigated by manipulating fluency while keeping intensity constant.

One boundary condition of the “louder as closer” effect seems to be that the location of the target person needs to be unknown during the judgment. When people have knowledge about where the target person is, as Study 3 shows, voice intensity no longer influences people’s distance estimations. Perhaps, the distance estimation task in Study 3 is quite different from the virtual localization task used in the first two studies. The virtual localization task, analogous to sound localization in unmediated situation, relies greatly on perceptual cues, including sound intensity. On the contrary, as the location is known, distance estimation is mainly affected by factors relating to mental representation of remembered space, such as map clutters (Thorndyke, 1981), reference points (Sadalla, Burroughs & Staplin, 1980), spatial categories (McNamara, 1986) and spatial boundaries (Burris & Branscombe, 2005), or by high-level processes, such as fluency (Alter & Oppenheimer, 2008) and construal level (Liberman & Föster, 2009).

The role of technology salience and presence

The second hypothesis was confirmed in Study 2. Use frequency of Skype clearly moderated the “louder as closer” effect. As participants used Skype more often, both the intensity effect on distance judgment and the negative correlation between perceived loudness and distance became stronger. This effect cannot be explained by the influence of sound quality: although the utilization of sound quality to judge distance differed greatly between users and non-users, this quality effect was not continuously moderated by use frequency. As we have argued, experienced users tend more to use voice intensity as a cue because the low salience of technology allows them to have the perceptual illusion of nonmediation. Therefore, we take this effect as an initial evidence for a negative relationship between technology salience and the strength of presence (cf. Lombard & Ditton, 1997). Future research needs to replicate the moderation effect of use experience, preferably with a different type of telecommunication technology.

One limitation of Study 2 was that the moderation effect of use experience was correlational in its nature, since use experience was only measured but not manipulated. In future
research, it is possible to select a new type of telecommunication technology and use a training paradigm to confirm the causal role of use experience (and indirectly the role of technology salience) in moderating the “louder as closer” effect. Another approach is to manipulate technology salience directly. Technology salience, as a cognitive variable in human technology interactions, is likely to be influenced by situational factors as well. When introducing Study 2, we have discussed that variations in voice intensity can be attributed to volume control of the technical system. Therefore, by experimentally inducing participants to make this attribution is a way to increase technology salience. For example, before the main procedure of Study 1, half of the participants can be asked to engage in an implicit volume-control task with a separate device, such as a MP3 player. The volume can be set below a normal level, so they will adjust the volume without being too suspicious about the purpose. As predicted by the technology-salience hypothesis, those who engage in the volume-control task will attribute intensity variation more to the technical system and will thus show reduced or even no “louder as closer” effect.

In future work, it is also interesting to investigate whether the “louder as closer” effect requires a certain level of presence. There are two properties in telecommunication that can be removed for this purpose – interactivity and real time (cf. Lombard & Ditton, 1997). First, by removing the possibility of interaction, the telecommunication paradigm will be transformed into a radio paradigm. Participants will be asked to listen to a piece of live speech before judging the location of speaker on a map. Taking one step further, by removing the property of real time, live sound will be replaced by pre-recorded sound. Similarly, participants will judge where the sound was recorded. In the last paradigm, it should be noted that there is virtually nothing to localize, so the whole localization process should be completely meaningless. These efforts will further clarify the role of presence (i.e., the perceptual illusion of nonmediation) in the effect we found.

**Underlying mechanism: an integrated two-stage model**

In this thesis, we proposed the “louder as closer” hypothesis on the basis of two different rationales. The embodiment rationale admits the disassociation of the concrete link between sound intensity and spatial distance in the context of telecommunication. By arguing that sound intensity as an embodiment for distance judgment, it suggests that people’s mental representation of a target person’s location will nonetheless be affected by intensity information. On the contrary, the presence rationale states that the intensity influence should remain because people
experience telecommunication as nonmediated. Since we have provided evidence for the effect across two studies, the next step is to ask which mechanism is indeed underlying the effect.

Based on the results, it seems that the presence rationale offers a more comprehensive explanation, because it explains both the “louder as closer” effect and the moderation role of use experience. However, this perspective has two limitations: (1) Although it suggests that people behave in the context of media technology in same way as they behave in the physical world (cf. IJsselsteijn, 2004; Lombard & Ditton, 1997; Reeves & Nass, 1996), it does not specify what is common underlying process in the two situations; (2) It cannot explain other effects caused by the interplay between sound intensity and distance, such as the results of the apparent-distance judgment paradigm (Petersen, 1990; Stevens & Guirao, 1962). The embodied rationale, on the contrary, specifies the underlying process, explains both the “louder as closer” effect and the results in the apparent-distance judgment paradigm, but does not predict the moderation role of technology salience.

Here, we integrate the two rationales and propose an alternative explanation framework for the underlying mechanism – a two-stage model. The first stage is an automatic transformation from intensity information to distance information. As distance judgment is partially embodied in sound intensity, this transformation is uncontrollable, regardless of whether the concrete link is relevant in a context. The second stage is the application of the transformed distance information in the judgment task at hand. The applicability depends on many contextual factors, including the strength of presence and technology salience in particular. If the presence is very low or the technology salience is very high, people’s knowledge about the technology (or media schemata, see IJsselsteijn, 2004) will reduce the applicability of the distance information. In other words, although the information has been transformed, people do not use it in their overt judgment. This model can easily account for the effects found in this thesis and other intensity-to-distance effects as well. It is also able to explain the boundary condition found in Study 3. According to the two-stage model, the sound intensity was still processed and transformed into distance information. However, since the location (the St. Catharina’s Church) is known, knowledge based processes (e.g., memory of the map) come in and override the transformed distance information suggested by the automatic process. In future research, more complex experiment is needed to empirically test the existence of the two stages in this model.
Concluding remarks

The most important finding in this thesis is the novel effect that people use voice intensity as a cue to judge target person’s distance in the context of telecommunication. This effect may have different implications concerning different perspectives. For embodied cognition research, our results imply that people’s conception of spatial distance might be embodied in many different perceptual experience (cf. Proffitt, 2006), including sound intensity. For presence research, we provide evidence for the notion of perceptual illusion of nonmediation from a different perspective from previous research (see Lombard & Ditton, 1997). The two-stage model we proposed suggests that the rationales from both perspectives are correct and each plays a role in the underlying process of the effect. Further testing on this model will greatly advance our knowledge. Overall, our research provides an example of studying human behavior in the context of novel technology to facilitate our understanding of basic psychological processes. We believe this is a promising approach which warrants more attention from researchers.
Voice Intensity Influences Distance Judgment In Telecommunication

References


