The illusion of nonmediation in telecommunication: voice intensity biases distance judgments to a communication partner.
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Abstract: The illusion of nonmediation is an experience in mediated communication where individuals respond as if the medium is not there. It is frequently associated with advanced media technology, such as virtual environments and teleconference systems. In this paper, we investigate whether people experience an illusion of nonmediation during interactions as simple as making a phone call. In three experiments, participants were asked to listen to someone’s voice on a mobile phone (Experiment 1) or through VoIP software (Experiment 2 and 3) before guessing the location of the person and indicating this location on a map. Results consistently demonstrated that louder voices were judged to be closer, as if the technical mediation was ignored. Combining the three experiments, a small-scale meta-analysis yielded an effect size estimate of $d = 0.37$ for the ‘louder-as-closer’ effect. Implications of the results and suggestions for future research are discussed.
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January 15th, 2015

Submission of a revision to Acta Psychologica

Dear Editor,

We hereby submit our revised manuscript "The Illusion of Nonmediation in Telecommunication: Voice Intensity Biases Distance Judgments to A Communication Partner" for publication to Acta Psychologica.

We received the editorial decision on our revised manuscript on December 29th, 2014. We were pleased that the editor and the reviewer evaluated the revision positively and judged the manuscript publishable given minor changes.

Accordingly, we revised the manuscript based on the two comments made by the reviewer. First, we explicitly mentioned the meta-analysis in the Abstract. Second, we explained in two footnotes why there were small differences among the sound pressure levels used in the three experiments.

The manuscript now has 4615 words (3572 for main text), and 3 Figures.

We hope you will find the revision satisfactory, and look forward to seeing the manuscript accepted for publication in Acta Psychologica.

Best regards,

Chao Zhang, MSc.
Dr. Daniel Lakens
Prof. Dr. Wijnand A. IJsselsteijn
**Highlights**

- Three experiments examined how communication technologies tend to “disappear”.
- Voice intensity biases distance judgments to a mediated communication partner.
- Presence can occur in simple media interactions, such as making a phone call.
- How interaction experience moderates the nonmediation illusion was explored.
Abstract

The illusion of nonmediation is an experience in mediated communication where individuals respond as if the medium is not there. It is frequently associated with advanced media technology, such as virtual environments and teleconference systems. In this paper, we investigate whether people experience an illusion of nonmediation during interactions as simple as making a phone call. In three experiments, participants were asked to listen to someone’s voice on a mobile phone (Experiment 1) or through VoIP software (Experiment 2 and 3) before guessing the location of the person and indicating this location on a map. Results consistently demonstrated that louder voices were judged to be closer, as if the technical mediation was ignored. Combining the three experiments, a small-scale meta-analysis yielded an effect size estimate of $d = 0.37$ for the ‘louder-as-closer’ effect. Implications of the results and suggestions for future research are discussed.

Word Count: 144 words
The Illusion of Nonmediation in Telecommunication:

Voice Intensity Biases Distance Judgments to a Communication Partner

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Author Note

Experiment materials and raw data are available from the Open Science Framework: https://osf.io/g9ydz/. Correspondence of this article should be addressed to Chao Zhang, PO Box 513, 5600 MB Eindhoven, The Netherlands. Email: chao.zhang87@gmail.com.
Abstract

The illusion of nonmediation is an experience in mediated communication where individuals respond as if the medium is not there. It is frequently associated with advanced media technology, such as virtual environments and teleconference systems. In this paper, we investigate whether people experience an illusion of nonmediation during interactions as simple as making a phone call. In three experiments, participants were asked to listen to someone’s voice on a mobile phone (Experiment 1) or through VoIP software (Experiment 2 and 3) before guessing the location of the person and indicating this location on a map. Results consistently demonstrated that louder voices were judged to be closer, as if the technical mediation was ignored. Combining the three experiments, a small-scale meta-analysis yielded an effect size estimate of $d = 0.37$ for the ‘louder-as-closer’ effect. Implications of the results and suggestions for future research are discussed.

Word Count: 144 words

KEYWORDS: Distance Judgment; Sound Intensity; Presence; Embodied Cognition; Telecommunication; Media
The Illusion of Nonmediation in Telecommunication:

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In the opening statement of his landmark paper “The computer for the 21st century”, Mark Weiser stated that “The most profound technologies are those that disappear. They weave
themselves into the fabric of everyday life until they become indistinguishable from it” (Weiser, 1991, p. 94). With the rapid development of mobile phones and voice over internet protocols, telecommunication has become one of the most profound technologies in today’s society (Cairncross, 1997). Has telecommunication technology become so profound that it disappears psychologically? In media psychology, the phenomenon that people do not fully acknowledge the role of technology in mediated experiences is known as presence, defined as the perceptual illusion of nonmediation (Lombard & Ditton, 1997; for more recent overviews, see IJsselsteijn, de Ridder, & Freeman, 2000; Lee, 2004). While research efforts in this field have primarily focused on multisensory, immersive and interactive media technologies (e.g., virtual environments, high-end videoconferencing, and tele-operation systems), we wondered whether the illusion also applies to the less immersive media that are used daily, such as a mobile phone.

Building on the idea that the frequent use of a technology enhances its cognitive transparency, making it “disappear”, we explore the possibility that people irrationally use the “louder as closer” cue from unmediated communication to judge distance in telecommunication.

In research with advanced presentation media, presence is usually conceptualized as a subjective experience, which can be expressed through certain bodily and behavioral responses (IJsselsteijn et al., 2000). Presence is said to occur either when people self-report their illusions
(Heeter, 1995; Slater & Usoh, 1993) or when their responses to mediated stimuli are identical to the responses they would have to similar unmediated stimuli (Heeter, 1995; Lombard et al., 1995; Reeves & Nass, 1996; IJsselsteijn, 2004). In the case of everyday telecommunication, people are not likely to explicitly report that they feel they share the same space with their communication partners. Even so, more subtle effects of presence, such as applying certain cognitive rules of face-to-face communication in mediated communication, might occur (cf. Reeves & Nass, 1996).

One such a rule is the association between someone’s voice intensity and spatial location. Because sound intensity decreases with increasing spatial distance in a predictable manner in the real world, people use intensity as the primary auditory distance cue (Zahorik, Brungart, & Bronkhorst, 2005). Many studies have shown that the association is well learned, as people are able to match different levels of sound intensity to corresponding distances (e.g., Petersen, 1990; Stevens & Guirao, 1962). In telecommunication a person’s voice intensity offers no valid information about the distance to his or her location due to the technological mediation. For example, during a phone call, the voice of someone from another country can be as loud as the voice of a person calling from next door. Despite that people should know this fact rationally, we hypothesized that people would erroneously consider a louder voice as a cue that their interaction partner is closer when they are uncertain about the true location of the interaction partner, because of the illusion of nonmediation.

As with other media, if presence does occur in everyday telecommunication, its strength should also vary together with many personal and situational factors (for a summary, see Lombard & Ditton, 1996). Here we focused on use experience as a factor, as the widespread use
of telecommunication is the most important reason why it might disappear psychologically (cf. Weiser, 1991). In line with this reasoning, increased interaction experience would thus lead to greater interface transparency and a stronger illusion of nonmediation. On the other hand, Lombard and Ditton (1996) have argued that increasing familiarity with a technology could hinder presence because people gradually adapt and gain more technical knowledge, thus allowing them to have a deeper appreciation of the properties of the mediating technology. In addition to examining the “louder as closer” effect” in three experiments, we explored whether interaction experience with the technology moderated this effect. In Experiment 1, we tested the “louder as closer” effect with a mobile phone. In Experiment 2, we replicated the “louder as closer effect” with voice over IP (VoIP, i.e., Skype), and explored the moderating role of interaction experience. In Experiment 3, we directly replicated Experiment 2 with a larger sample for a confirmatory test of the moderation effect.

**Experiment 1**

**Method**

*Participants and design*. Forty-four people (16 females) voluntarily participated in the experiment. They were randomly assigned to a softer voice condition (41 dB) or a louder voice condition (52 dB).

*Procedure*. Students passing through the central library at Eindhoven University of Technology (TU/e) were randomly asked to help with an ostensible phone call quality test. Upon

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1 Experiment materials and raw data are available from the Open Science Framework: [https://osf.io/g9ydz/](https://osf.io/g9ydz/)
agreeing to participate, they were asked to use a mobile phone provided by the experimenter to answer a call from a research assistant who was described as “being somewhere on the campus”. Participants were randomly assigned to the softer or louder voice condition by the research assistant who made the phone calls, ensuring that the experimenter was blind to the conditions. During the 30-second phone call, they listened to a segment of pre-recorded English speech with different volumes manipulated by the assistant. Afterwards, participants were shown an abstracted campus map (see Figure 1) and were asked to mark the location of the caller on the map based on their intuition. Next, they were asked to answer a 5-item questionnaire concerning perceived loudness, sound quality, processing fluency, liking and familiarity with the speech (all on 7-point scales). Finally, they were debriefed and thanked.

Results and discussion

The data of two participants were excluded based on pre-defined criteria. One participant marked the location of the train station based on the content of the call. The other judged the location as the building of the experimenter’s faculty. This left 20 participants in the softer voice condition, and 22 participants in the louder voice condition. The manipulation check confirmed that participants perceived the voice intensity in the softer condition as softer ($M_{\text{softer}} = 2.75$, $SD_{\text{softer}} = 1.12$) than in the louder condition ($M_{\text{louder}} = 4.00$, $SD_{\text{louder}} = 1.38$), $t(40) = 3.21$, $p = .003$; Cohen’s $d = 0.99$). Distance judgments were computed by measuring the Euclidean distance (in centimeters) between participants’ marked locations and the library. As expected, participants judged the caller’s location to be nearer if they heard a louder compared to a softer voice ($M_{\text{softer}} = 9.93$, $SD_{\text{softer}} = 3.61$; $M_{\text{louder}} = 7.34$, $SD_{\text{louder}} = 3.77$; $t(40) = 2.27$, $p = .029$; Cohen’s $d = 0.70$, 95%
CI [0.07, 1.32])². On the contrary, the intensity manipulation did not result in significant differences on other measured dimensions (quality, fluency, liking and familiarity). The results provide initial support for the “louder as closer” effect.

**Experiment 2**

We aimed to replicate the “louder as closer” effect with a different type of telecommunication in Experiment 2. At the time of Experiment 2, in 2012, VoIP (e.g., Skype) was quickly gaining popularity among young people, becoming a cheaper alternative for long-distance calls. Compared with calling using a mobile phone, however, the technological salience of a Skype call (using a notebook and a headphone) was much higher, which might suspend the illusion of nonmediation (cf. Lombard & Ditton, 1997). Therefore, we chose VoIP to test whether the effect could replicate and generalize the “louder as closer” effect. Another motivation for choosing VoIP was that there were large individual differences in how much experience Dutch students have in using VoIP software. This fact allowed us to explore the moderating role of interaction experience. We expected that the “louder as closer” effect would be stronger with increasing interaction experience people reported to have with VoIP, as this would enhance the cognitive transparency of the technology.

**Method**

*Participants and design.* Sixty-seven Dutch students (20 females, mean age 22.3) voluntarily participated in the experiment. They were randomly assigned to a softer voice

² With those two data points included, the “louder as closer” effect was $t(42) = 1.82, p = .075$; Cohen’s $d = 0.55, 95\% CI [-0.06, 1.15]).
condition (43 dB) or a louder voice condition (63 dB)³.

Procedure. The procedure was identical to Experiment 1, except for the following changes. First, participants were equipped with a notebook and a headphone, and they were asked to make a call to the assistant’s mobile phone using Skype. Second, 22-seconds of pre-recorded Dutch speech was presented as the stimulus. Participants were made to believe that the speech was an experiment introduction by the research assistant in real time. Third, as people’s experience with Skype may differ greatly, we added two items to the questionnaire – use frequency and evaluation of VoIP, both measured on 7-point scales.

Results and discussion

One participant failed to complete the experiment because of a technical problem. Three other participants were excluded based on pre-defined criteria. Two participants demonstrated strong suspicions that the voice was pre-recorded, and one judged the location as the building of the experimenter’s faculty.⁴ This left 32 participants in the softer voice condition, and 31 participants in the louder voice condition. The manipulation check confirmed that participants in the softer condition perceived the voice as softer ($M_{soft} = 2.84, SD_{soft} = 1.05$) than those in the louder condition ($M_{louder} = 5.35, SD_{louder} = 0.71$), $t(61) = 11.08, p < .001, Cohen’s d = 2.79$. As with Experiment 1, distance judgments to the communication partner were larger in the softer condition ($M_{soft} = 9.15, SD_{soft} = 3.03$) than in the louder condition ($M_{louder} = 7.80, SD_{louder} = 3.32$).

Although the obtained effect was not significantly different from zero ($t(61) = 1.68, p = .098, d = 3$ Since we had more control in the VoIP setting, we increased the sound pressure level (SPL) difference to strengthen the manipulation.

⁴ With those three data points included, results did not change to any mentionable extent.
0.42, 95% CI [-0.08, 0.92]), the results indicated a replication of Experiment 1 in terms of the overlapping confidence intervals of effect size (cf. Cumming, 2012).

To explore the potential moderating effect of use frequency, a moderated linear regression analysis was performed. Results showed that participants who used VoIP more often were more likely to be influenced by voice intensity in their distance judgments ($\beta_{\text{moderation}} = -0.444$, $p = .021$, $\Delta R^2 = .082$). Moreover, when the whole sample was split into VoIP non-users (use frequency ≤ 1, “very rarely”; n = 24) and users (use frequency > 1; n = 39), a two-way ANOVA revealed a significant interaction between the intensity condition and participant type, $F(1, 59) = 5.91$, $p = .018$; $\eta^2 = .086$ (see Figure 2). Simple effects demonstrated a strong “louder as closer” effect for users ($M_{\text{softer}} = 9.54$, $SD_{\text{softer}} = 2.78$; $M_{\text{louder}} = 6.67$, $SD_{\text{louder}} = 2.48$; $t(37) = 3.39$, $p = .002$; Cohen’s $d = 1.09$, 95% CI [0.41, 1.76]), but no differences in distance judgments for non-users ($t(22) = -.661$, $p = .52$).

Regarding the other measured variables, only perceived fluency revealed a statistical difference from 0 between the two conditions ($t(61) = -3.40$, $p = .001$; Cohen’s $d = 0.86$) – participants in the softer condition found it harder to hear the voice clearly than those in the louder condition ($M_{\text{soft}} = 4.31$, $SD_{\text{soft}} = 1.31$; $M_{\text{loud}} = 5.52$, $SD_{\text{loud}} = 1.50$). As perceived fluency also correlated with distance judgment ($r = -.368$, $p = .003$), it might confound the “louder as closer” effect. Therefore, we performed ANCOVAs with fluency as a covariate for the whole sample and for users. For the whole sample, the effect of intensity condition on distance judgment was rendered undetectable ($F(1, 60) = 0.335$, $p = .56$; $\eta^2 = .005$). However, for users, the influence of

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5 The absence of an effect should be treated with caution since the sample size of non-users was quite small.
intensity remained significant \((F(1, 36) = 5.16, p = .029; \eta^2 = .10)\), which testified to the unique contribution of voice intensity.

**Experiment 3**

In the previous two experiments, we successfully demonstrated the “louder as closer” effect derived from presence theory. In Experiment 2, we also explored the moderating role of use experience and found positive results, in that more experienced users appear to be more sensitive to the illusion of nonmediation. In the third experiment, we directly replicated Experiment 2 in order to provide a preregistered\(^6\) confirmatory test of the moderation observed in Study 2 in a larger sample.

**Method**

*Participants and design.* One hundred and fifty-nine Dutch students (36 females, mean age = 21.8, 22 were VoIP non-users) were recruited for the experiment. The sample was determined to achieve 90% power of detecting the moderation effect of interest at the conventional 0.05 level.

As in Experiment 1 and 2, participants were randomly assigned to either a softer (41 dB) or a louder voice condition (58 dB)\(^7\).

*Procedure.* The procedure was identical to Experiment 2, except that participants were asked whether they had ever used any VoIP software before participating in the experiment. There was also a change of the map used to measure distance judgments due to the relocation of the

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\(^6\) The pre-registration form can be downloaded from the project page on the Open Science Framework: https://osf.io/g9ydz/

\(^7\) We initially used the same SPLs as with Experiment 2, measured by a SPL meter. However, due to the calibration difference from the last measurement (2 years ago), the actual SPLs were both higher as detected by loudness ratings in a pilot, resulting in a weak manipulation. We therefore lowered the two SPLs by human judgment and measured the adjusted values with the meter afterwards.
Results and discussion

Seventeen participants were excluded based on pre-defined criteria: 10 of them strongly suspected that the voice was pre-recorded; 3 students identified the voice and judged the location according to the assistant’s faulty building; 2 persons had participated in Experiment 2 two years earlier; 1 person was excluded because of a procedural error; and 1 made a random guess by dropping his pen onto the paper. This left 70 participants in the softer voice condition, and 72 participants in the louder voice condition.

The manipulation was effective as the participants in the softer condition ($M_{\text{softer}} = 4.13$, $SD_{\text{softer}} = 0.96$) indeed perceived the voice as softer than those in the louder condition ($M_{\text{louder}} = 5.57$, $SD_{\text{louder}} = 0.75$), $t(140) = 9.98, p < .001$, Cohen’s $d = 1.67$. As with the previous two experiments, participants in the softer condition made larger distance judgments than those in the louder condition ($M_{\text{softer}} = 4.60$, $SD_{\text{softer}} = 2.80$; $M_{\text{louder}} = 3.89$, $SD_{\text{louder}} = 2.57$; Cohen’s $d = 0.26$, 95% CI = [-0.04, 0.62], although the effect was not statistically different from zero ($t(140) = 1.58, p = .117$). When the hypothesis was tested only among VoIP users, we obtained a slightly larger effect ($M_{\text{softer}} = 4.74$, $SD_{\text{softer}} = 2.73$ $M_{\text{louder}} = 3.80$, $SD_{\text{louder}} = 2.89$; Cohen’s $d = 0.34$, 95% CI = [-0.02, 0.70]), $t(118) = 1.83, p = .069$). Critically, when we tested the a priori prediction of the moderation effect through a moderated regression analysis, the results failed to reveal any indication of a moderation of the louder as closer effect by use experience ($\beta_{\text{moderation}} = 0.067, p$

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8 With those 17 data points included, results did not change to any mentionable extent.
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= .578, ΔR² = .002), which is not in line with our predictions.

Among other measured variables, sound quality and perceived fluency significantly differed
between the two conditions. Sound quality was judged to be better in the louder compared to the
softer condition (M_{softer} = 5.44, SD_{softer} = 0.96; M_{louder} = 6.10, SD_{louder} = 0.82), t(140) = -4.37, p
< .001 Cohen’s d = 0.73). Also, participants thought that they could hear the voice more clearly in
the louder rather than the softer condition (M_{softer} = 5.67, SD_{softer} = 1.03; M_{louder} = 6.40, SD_{louder} =
0.64), t(140) = -5.09, p < .001, Cohen’s d = 0.85. Nonetheless, since both quality (r = -.081, p
= .341) and fluency (r = -.087, p = .306) did not correlate with distance judgment, they were
unlikely to contaminate the effect of voice intensity.

In Experiment 3, a thorough debriefing was used to probe participants’ self-explanation of
their distance judgments. Everyone was asked about his or her rationale of marking the location
they did, and most participants answered these debriefing questions. Thirteen participants
mentioned that there might be a link between voice intensity and their distance judgments, either
spontaneously or when this possibility was explicitly suggested. Twenty-nine of them based their
judgments on the quality of the sound. They believed that if the voice was clear, the location was
likely to be nearby. Thirty-two paid attention to whether there were background noises during the
call. Then they used the noise levels to evaluate the likelihood of being in a particular building.
Yet another 18 thought about the acoustics of the voice (hollow sound, reverb, etc.) and came up
with one particular environment accordingly. Overall, it seemed that the majority of the people
were not aware of the influence of voice intensity.
**Meta-analysis of the “louder as closer” effect**

We conducted three experiments to answer the question whether people’s judgments of a communication partner would be biased by voice intensity during telecommunication. The results we observed were all in the predicted direction, but not statistically significant in each individual study ($p = .029$, Experiment 1, $p = .098$, Experiment 2, $p = .117$, Experiment 3). However, there was considerable overlap in the confidence intervals around the effect size estimates. The lack of consistent significant results could be due to low statistical power. Because of the novel and exploratory nature of this set of studies, the sample sizes for Experiment 1 and 2 were quite arbitrary, and a sequential analyses approach would have been preferable (see Lakens, 2014; Lakens & Evers, 2014). The power analysis used in Experiment 3 (as detailed in the pre-registration) was based on the effect size of the moderation effect. However, since this prediction was not confirmed in Experiment 3, it would in retrospect have been better to use the effect size estimate of the main effect ($d = 0.42$) in Experiment 2. Based on this effect size, 90% power would require 242 rather than 142 participants.

We believe that the best approach to evaluate the three experiments is to perform a small-scale meta-analysis on the “louder as closer” effect over all three studies with a total $N = 247$ (cf. Borenstein, Hedges, Higgins, & Rothstein, 2011, Cumming, 2012). A random-effect model meta-analysis yielded strong support to the alternative hypothesis, overall Cohen’s $d = 0.37$, 95% CI [0.12, 0.62], $t = 2.89$, $p = .004$ (for the forest plot, see Figure 3). As would be expected when meta-analyzing close replications, there was no indication of heterogeneity in the three experiments, $Q(2) = 1.58$, $p = .453$, $\tau^2 = 0.0%$. The results indicated that the predicted bias in
distance judgments was probably larger than zero, although it was likely somewhat smaller than the first two experiments suggested.

**General Discussion**

Across 3 experiments, we tested whether voice intensity during telecommunication would bias people’s distance judgments to their communication partners, using both mobile phone and VoIP technology. We found evidence that suggests a “louder as closer” effect, and a meta-analysis suggested a small-to-moderate effect size. This effect provides support for the theoretical notion that telecommunication users experience an illusion of nonmediation and thus adopt the “louder as closer” rule from face-to-face communication. That is, participants appear to judge differences in mediated voice intensity levels according to differences in real-world distances, thus not fully acknowledging the role of the mediating technology. Unfortunately, the moderating role of interaction experience uncovered in Experiment 2 did not replicate in Experiment 3. Therefore, whether or when repeated use of a telecommunication technology affects the “louder as closer” effect remains an open question.

The moderation effect of interaction experience would have provided a strong test for presence theory, as there can be hardly other reasons why interaction experience should influence the strength of the main effect. Lacking this evidence, one might consider the possibility that the bias happens in the absence of the proposed illusion. In a broader sense, the experimental task resembles a “judgment under uncertainty” paradigm (cf. Tversky & Kahnemann, 1974), where people make judgments with scarce information. In such a situation, the “louder as closer” rule, despite being irrational, may still be easily activated. Embodied cognition research has
demonstrated that some deeply learned associations could influence judgments even when the perceptual cues are contextually irrelevant (for a review, see Barsalou, 2008). For instance, people were found to treat a questionnaire as more important when they held a heavier compared to a lighter clipboard (Jostmann, Lakens, & Schubert, 2009). The association between physical weight and importance is well learnt so processing the former is likely to activate the latter (cf. Barsalou, 1999). The association between intensity and distance may just be strong enough to be adopted in mediated communication. To confirm that presence is a prerequisite for the use of the rule, future studies need to examine the role of technology more directly, for instance by manipulating people’s experience with a technology or the salience of technology in a given telecommunication context.

In addition, the current research leaves two issues concerning the underlying mechanism open for further investigations. First, our results are inconclusive about whether the process is automatic or under conscious control. Some participants reported that they thought about the “louder as closer” rule while making the judgments, but the majority disregarded such an influence. Second, we do not know much about how voice intensity interacts with other location cues during telecommunication. We suspect that the “louder as closer” rule may no longer be relied on when more informative cues become available. In a separate experiment, when participants were asked to estimate the distance to an interaction partner in a known location (in front of a church in the center of town) there was no influence of voice intensity on participants’
distance estimation to that location\textsuperscript{9}.

Twenty years after Mark Weiser’s vision, we demonstrate empirically what it can mean for technologies to disappear and weave themselves into the fabric of everyday life. When interacting with a technology as common as telecommunication, people make judgments based on the voice intensity of their communication partners in a similar way as if the technological mediation was not there. We hope that more research will investigate the role of presence and the underlying mechanisms to better understand the cognitive nature of the presence phenomenon.

\textsuperscript{9} This study is not reported in more detail here because it used a different paradigm and revealed no effects. However, interested readers can find a summary and the data on the Open Science Framework: http://osf.io/g9ydz/
Acknowledgements

The authors thank Linda Bäbler for her excellent help on executing the third experiment. Thanks to Ze Li, Shengnan Lu and Roelof Lochmans for acting as the assistants in the three studies. Also thanks to Martin Boschman, Kees Kuijpers and Aart van der Spank for helping with technical issues.
References


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185, 1124–1130.


**Figure 1.** The abstraction of the TU/e campus map used in Experiment 1 (the star marks the central library at TU/e).

**Figure 2.** Distance judgments (centimeters) of users and non-users in the softer and louder conditions of Experiment 2. Error bars are one SE above and below the point estimates.
Figure 3. Forest plot of the meta-analysis.
The abstraction of the TU/e campus map used in the experiments

The figure represents the abstraction of the TU/e campus map used in the experiments. The star marks the central library at TU/e (where the participants were during the experiment) at the time Experiments 1 and 2 were performed (see the experimental materials for the map used in Experiment 3). Participants were asked to mark the location of the research assistant within the range of this map.
Distance judgments of users and non-users in the softer and louder conditions

Bar chart of the distance judgment data in Experiment 2, sorted by user type (users and nonusers) and intensity condition (softer and louder). The vertical axis represents distance in centimeters. The error bars are one SE above and below the point estimates.
Forest plot of the meta-analysis

The forest plot summarizes the results of the meta-analysis, with the squares representing the estimated effect sizes in the three individual experiments, and the bars indicating their 95% confidence intervals. The rhombus represents the estimated meta-analytic effect size and its 95% confidence interval.