

Designing Social Presence of Social Actors in Human Computer Interaction

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ABSTRACT

This study examines the interaction effect between user factors and media factors on feelings of social presence which are critical in the design of virtual reality systems and human computer interfaces. Both Experiment 1 and Experiment 2 show that matching synthesized voice personality to user personality positively affects users' (especially extrovert users') feelings of social presence. Experiment 2 also reveals that users feel a stronger sense of social presence when the personality of synthesized voice matches the personality of textual content than when those two are mismatched. In both experiments, extrovert voice induces a stronger sense of presence than introvert voice. These results provide strong evidence for human's automatic social responses to artificial representations possessing humanistic properties such as language and personality. Finally, we discuss various applications of these findings in the design of human computer interfaces, as well as in the study of presence.

Keywords: social presence, presence, telepresence, similarity-attraction, consistency-attraction, computers are social actors, media equation.

INTRODUCTION

In this paper, we examine whether one can influence users' feeling of social presence in voice-mediated human-computer-interaction (HCI) merely by manipulating paralinguistic cues (e.g., pitch range, speech rate, fundamental frequency, etc.) of synthesized speech. Paralinguistic cues of synthesized speech are manipulated according to either the personality of a listener which is measured by a standardized personality scale or the

personality of a text which is manipulated by changing writing styles (e.g., word choice, length, confidence expression, etc.). We test the idea that with neither artificial intelligence (AI) nor high-end virtual reality devices (e.g., head mounted display, ImmersaDesk, 3D surround speakers, etc.), one can increase feelings of social presence in HCI by following social rules governing human-to-human interaction. We discuss design implications for HCI, voice user interface (VUI) and VR systems and argue for a new approach in social presence research.

PRESENCE

Researchers and Human Computer Interaction (HCI) designers have begun to realize that the feeling of presence is at the heart of all mediated vicarious experiences, from reading a novel [15] to riding an immersive virtual reality (VR) simulator [17], because presence is at the heart of humans' desire to use media to move beyond the limits of body and the sensory channels [6]. As a result, the concept of presence has become central to theorizing about advanced human-computer interface such as VR systems [5, 18, 24, 26, 42, 44, 45, 49], as well as traditional media such as television, film, and books [9, 22, 25].

After an extensive review of presence-related concepts and their explications, Lombard and his colleagues define presence as "the perceptual illusion of nonmediation" [25, p 77; for other definitions, see, e.g., 41; 45; 49]. The term "perceptual" means that presence "... involves continuous (real time) responses of the human sensory, cognitive, and affective processing systems to objects and entities in a person's environment" [25, p 77]. By "illusion of nonmediation," they refer to a phenomenon in which "... a person fails to perceive or acknowledge the existence of a medium in his or her communication environment and responds as he or she would if the medium were not there" [25, p 77].

HCI researchers and VR designers have tended to focus on *physical* presence [3; 22; 24; 39; 43], the extent to which people feel that they are in a virtual world [5; 17]. However, an equally important dimension of presence is *social presence*, the sense that other intelligent beings co-

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exist and interact with you [17], even if those beings are non-human and only seem intelligent [5].

The possibility that social presence can also be created through agents or through the machine itself (e.g., computers, e-toys such as Sony's Aibo, bots, etc.) has tremendous theoretical and practical import. Theoretically, it suggests a new line of thinking about our interaction with artifacts [see 35, 40] and what it is to be human [32]. Moreover, the growing trend of projecting oneself into mediated virtual environments (via agents and avatars) and increasing communications among projected selves [27, 48] have called for a systematic study of how people make sense of virtually presented others. Practically, the recent growth of multi-user computer games and anecdotal evidence indicate that users strongly prefer to interact with others [17] across a wide range of media products [40]. Social presence has also been argued to facilitate persuasion [13] and sales in e-commerce [29].

The previous literature has suggested two types of variables that affect social presence: media variables and individual differences [24, 25, 49]. As far as media variables, presence has been argued to be associated with the number of sensory dimensions and channels presented and engaged [22, 24, 45], image quality [7], image size [22, 25], narrative quality [38], production techniques [51], sound fidelity [39], and the presence of other people in the medium [17]. As far as user variables, researchers argue that presence is positively related to willingness to suspend disbelief [23, 24], prior exposure to media [24], gender [21, 24, 25], and mood, especially sensation-seeking mood [1].

A MISSING SET OF VARIABLES

There is a third set of variables that have not been explored in previous studies of presence: People's social responses to media [40]. Under the Computers are Social Actors paradigm [35, 40], researchers have consistently demonstrated that individuals unconsciously attribute human characteristics (e.g., gender, ethnicity, etc.) to media and media representations and apply social rules and expectations when they interact with media. The application of these social categories and rules affects judgments about and processing of the artifact. The primary characteristics of media that seem to cue these social responses are the use of language [8], interactivity [35], and voice [37].

Of most relevance to the present research, a series of studies have demonstrated that people respond to media representations as if they had a personality. Characteristics of textual content [30, 36], character appearance [20], and character behavior [2, 40] have been shown to cue the classification of personality. Importantly, users go beyond identification to apply a wide variety of rules about how to *respond* to personality.

Despite the breadth and depth of these responses to artifacts, the literature has never determined whether

social characteristics of artifacts would influence feelings of social presence. In this paper, we address this limitation by exploring the effects of aspects of technology that suggest personality on feelings of social presence. To demonstrate the strength of these effects, we explore personality and social presence using *synthetic speech*, speech that is clearly not human.

Based on the Computers Are Social Actors argument, this paper proposes that people will *interpret* and *respond* to the non-verbal cues of synthesized speech in the same way as they would to real human speech. Our primary hypothesis is that people's social responses to synthesized speech would affect their feeling of social presence of the virtual actors who (ostensibly) created the content (for a similar argument, see [8]). In two experiments, we test the effect of three aspects of social interactions on social presence: 1) similarity-attraction, 2) consistency-attraction, and 3) greater social presence of extroverted people.

SOCIAL RULES AND SOCIAL PRESENCE

Similarity-attraction

Similarity-attraction predicts that a person will be more attracted to others who match their personalities than to those who mismatch. Similarity-attraction is an extremely robust finding in both human-human and human-computer interaction (see [35, 36] for reviews). Attraction, in turn, leads to a desire for interaction and increased attention in both human-human [4, 16, 28] and human-computer interaction [46]. This focused and selective attention should lead to increased feeling of presence [14, 49]. Thus, in the context of speech user interfaces, we predict that:

Hypothesis 1. Users hearing a computer voice manifesting a personality similar to themselves will feel more social presence than those who hear a computer voice manifesting a dissimilar personality.

Consistency-attraction

Consistency-attraction predicts that people will like and prefer those who show behavioral consistency, as it leads to predictability and decreases cognitive load [12]. In particular, people are sensitive to discrepancies between verbal (textual) and non-verbal (personality) cues [10]. Of course, traditional media content creators have long been concerned with establishing consistency in all aspects of the presentation [11, 20, 47]. In virtual environments, people also prefer to interact with an object designed in a consistent way [19], likely because it reduces cognitive load and decreases disbelief.

The reduced cognitive load and decreased disbelief associated with consistency may make it easier for users to become deeply engrossed in the virtual environment and increase feelings of social presence. Thus, virtual actors that exhibit consistency between the words they say and their vocal characteristics may be perceived as being more present than inconsistent actors. Thus, we predict the following:

Hypothesis 2. Users hearing a computer voice manifesting vocal characteristics consistent with the content will feel more social presence than those who hear a computer voice exhibiting inconsistency between vocal features and content.

Extroversion and social presence

In addition to the interactions between voice personality and user personality and voice personality and content, there can also be a main effect for voice personality. Extroverts are more socially present, as they have louder voices [34], speak more [40, chap. 7], take up more physical space with broader gestures and body postures [20], and initiate more conversations [31] than introverts. This leads to the following:

Hypothesis 3. An extrovert voice will induce a stronger feeling of social presence than an introvert voice.

Gender

Some recent studies have suggested that there are gender differences in presence judgment. For example, Reeves, Detenber, and Steuer [39] found that large screens increase female participants' feeling of presence, whereas small screen increase male participants' feeling of presence. Hence, we will determine whether gender affects the perceived presence of computer-synthesized speech.

EXPERIMENT 1¹

Overview

This experiment was a 2 (Participant Personality: Extrovert vs. Introvert) x 2 (Computer Voice Personality: Extrovert vs. Introvert) between-subject factorial design. Among numerous dimensions of personality that have been identified (see [31, 50], for review), we focus on the extroversion/introversion dimension, because this dimension is most strongly marked by paralinguistic cues [20].

Method

Participants

Several weeks prior to the study, a web-based personality survey was administered to students who registered for a large introductory communication course. Both Myers-Briggs [31] and Wiggins [50] personality tests were administered to maximize the likelihood of correctly assessing the personality of students. From a total of approximately 150 undergraduate students, a total of 72 participants—36 extrovert and 36 introvert students who had the most extreme scores on the two scales—who had English as a first language were invited to participate in the study. Participants were randomly assigned to

condition, with gender approximately balanced across conditions.

Procedure

This experiment was executed in the context of a book-buying web site that presented five different books, all on the same web page. The web page had a visual interface based on Amazon.com's book descriptions. Instead of having the book description in text, there was a link to an audio (.wav) file; participants clicked on the link to play the review. Participants read the instruction on the web page and heard five book descriptions via either an extrovert or an introvert synthetic voice. After hearing the book descriptions, participants were presented with a web-based questionnaire regarding the feeling of social presence. Finally, all participants were debriefed and thanked.

Each participant was assigned to a computer equipped with headphones and an Internet Explorer 4.0 browser. Participants were instructed to use the headphones during the whole experiment and not to adjust the volume level of either the headphone or the computer.

Manipulation

Four voice parameters were simultaneously manipulated to instantiate the personality of the voice. The extrovert voice had a speech rate of 216 words per minute, the original volume level; a fundamental frequency of 140Hz; and a pitch range of 40Hz. The introvert voice had a speech rate of 184 words per minute; the volume level set at 15% of the original; a fundamental frequency of 84 Hz; and a pitch range of 16 Hz (see [34] for a justification of the above voice parameters). The textual content for the five book descriptions were identical across conditions.

Measures

All measures were based on items from the web-based, textual questionnaires. Participants used radio buttons to indicate their responses. Each question had an independent, ten-point Likert scale.

Extrovertedness/Introvertedness of the voice was an index composed of ten Wiggins [50] personality adjective items: Cheerful, Enthusiastic, Extroverted, Introverted (reverse coded), Inward (reverse coded), Jovial, Outgoing, Perky, Shy (reverse coded) and Vivacious (Cronbach's $\alpha = .89$). The question asked "How well do the following adjectives describe the voice," followed by a scale ranging from "Describes Very Poorly" (1) to "Describes Very Well" (10). The higher the score, the more extrovert the voice.

Social presence was an index composed of following four questions: 1) While you were hearing the reviews, how much did you feel as if someone talking to you?, 2) How involving was the whole hearing session?, 3) While hearing the reviews, how vividly were you able to mentally imagine the source of voice?, and 4) How much attention did you pay to what was being said? The response scale for each question was anchored by "Not at all" (1) and

¹ Some of the data reported in Experiment 1 and Experiment 2 were previously reported in Nass & Lee (2001). Neither the key variable in the current study, social presence, nor any of the analyses were reported previously.

“Very Much” (10). The index was highly reliable ($\alpha = .89$).

Results

All analyses are based on a full-factorial 2 (user personality) x 2 (computer voice personality) ANCOVA using gender as a covariate.

The manipulation was successful: The extrovert computer voice was perceived as being more extroverted ($M = 4.86$) than the introvert computer voice ($M = 3.34$), $F(1, 67) = 23.7, p < .001, \eta^2 = .26$. There was neither a main effect of user personality nor an interaction effect.

Hypothesis 1 was supported. We found a significant cross-over interaction between computer voice personality and subject personality for social presence, such that respondents felt stronger social presence when they heard a computer voice manifesting a personality similar to their own, $F(1, 67) = 11.1, p < .001, \eta^2 = .14$. Specifically, introverts felt stronger social presence when they heard the introvert voice ($M = 4.1, S.D. = 1.4$) than when they heard the extrovert voice ($M = 3.8, S.D. = 1.2$), while extroverts felt more social presence when they heard the extrovert voice ($M = 4.3, S.D. = 1.8$) as compared to the introvert voice ($M = 2.4, S.D. = 0.9$). These results also indicate that extroverts are more sensitive to personality-match than introverts.

Consistent with Hypothesis 3 (Hypothesis 2 is examined in Experiment 2), a significant voice personality main effect was also found, $F(1, 67) = 6.65, p < .05, \eta^2 = .09$: The extrovert voice ($M = 4.1, S.D. = 1.5$) produced more feeling of social presence than the introvert voice ($M = 3.2, S.D. = 1.4$). There was no main effect of user personality for social presence, $F(1, 67) = 3.20, not\ significant\ (n.s.)$ (see Figure 1).

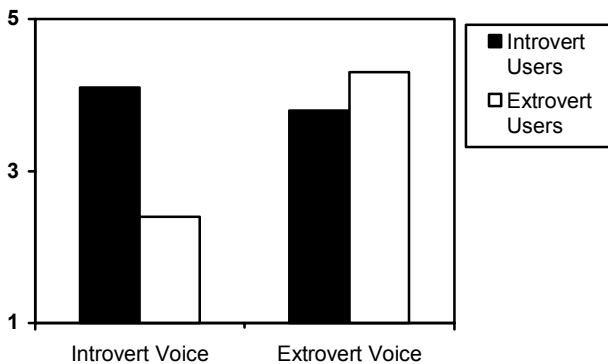


Figure 1. The effect of similarity-attraction and voice personality on social presence

Gender did not have a significant effect, either as a covariate or as a third factor, $F(1, 67) = 0.32, n.s.$

EXPERIMENT 2

Overview

In the first experiment, we used personality-neutral content to control the influence of the verbal channel on users’ psychological responses to computer-synthesized speech. However, a great deal of computer and Web content, especially emails, personal narratives, and highly branded content, manifest a clear personality via text. Will inconsistencies between the voice and the content affect social presence? In this experiment, we replicate and extend the ideas behind the first study by examining both similarity-attraction and consistency effects in a context in which both the linguistic cues manifested by text input and the paralinguistic cues conveyed by TTS² output provide personality cues.

This second study was executed in the context of an online auction website. Each web page had an identical visual interface based on E-Bay’s auction item descriptions. Each page included the names and pictures of 9 antique or collectible auction items (e.g., 1963 classic lamp, 1920s radio, 1968 Russian circus poster, etc.). Instead of having the item description in text, there was a link to an audio (.wav) file for each item; clicking on the link played the description of the item; all descriptions for a given participant were read with the same voice.

Method

Participants

Procedures for identifying extrovert and introvert participants were identical to Experiment 1. From two undergraduate introductory classes, a total of 80 participants—40 extrovert and 40 introvert students—were invited to participate in the study. Gender was approximately balanced and all participants were native speakers.

Procedure

All participants were randomly assigned to condition in a 2 (participant personality: extrovert vs. introvert) by 2 (computer voice personality: extrovert vs. introvert) by 2 (text personality: extrovert vs. introvert) balanced between-subject design.

Manipulation

The personality of voice was manipulated as in Experiment 1. The extroversion or introversion of item descriptions was operationalized by manipulating the phrasing of the description. Following previous studies (e.g., [20], the introvert description was relatively short and used weaker language expressed in the form of suggestions. Conversely, the extrovert description was relatively lengthy and used strong and friendly language expressed in the form of confident assertions. For example, the extroverted description of the lamp read:

² "TTS," standing for "text to speech," is the traditional abbreviation for "synthesized speech."

This is a reproduction of one of the most famous of the Tiffany stained glass pieces. The colors are absolutely sensational! I am sure that this gorgeous lamp will accent any environment and bring a classic touch of the past to a stylish present. It is guaranteed to be in excellent condition! I would very highly recommend it.

Conversely, the introverted description of the lamp read:

This is a reproduction of a Tiffany stained glass pieces. The colors are quite rich. The hand-made copper-foiled stained glass shade is about six and one-half inches in diameter and five inches tall.

Measures

Extrovertedness/Introvertedness was computed as in Experiment 1. It was used for personality assessments of the TTS voice (Cronbach’s $\alpha = .92$), and the narrated text ($\alpha = .90$).

Social presence was measured as in Experiment 1; the index was reliable ($\alpha = .77$).

Results

All analyses were based on a full-factorial 2 (Subject personality) X 2 (Computer voice personality) X 2 (Text personality) ANCOVA model with gender as a covariate. The manipulations were successful: The extrovert computer voice was perceived as being clearly more extroverted ($M = 5.6, S.D. = 1.9$) than the introvert computer voice ($M = 4.2, S.D. = 1.3$), $F(1, 71) = 21.23, p < .001, \eta^2 = .23$. Similarly, the extrovert text was perceived as being clearly more extrovert ($M = 6.4, S.D. = 1.3$) than the introvert text ($M = 4.6, S.D. = 1.0$), $F(1, 71) = 57.2, p < .001, \eta^2 = .45$.

Replicating the result of Experiment 1, Hypothesis 1 was supported. There was a significant cross-over interaction between computer voice personality and subject personality for social presence, such that respondents felt stronger social presence when they heard a computer voice manifesting a personality similar to their own, $F(1, 71) = 15.8, p < .001, \eta^2 = .18$. For the extrovert voice, extrovert participants ($M = 6.0, S.D. = 1.6$), found the voice to be more present than introvert participants ($M = 4.8, S.D. = 1.3$), while for the introvert voice, introvert participants ($M = 4.8, S.D. = 1.0$) found the voice to be more present than extrovert participants ($M = 3.8, S.D. = 1.3$) (see Figure 2). As in Experiment 1, extrovert participants were clearly more sensitive to personality-match than introvert participants.

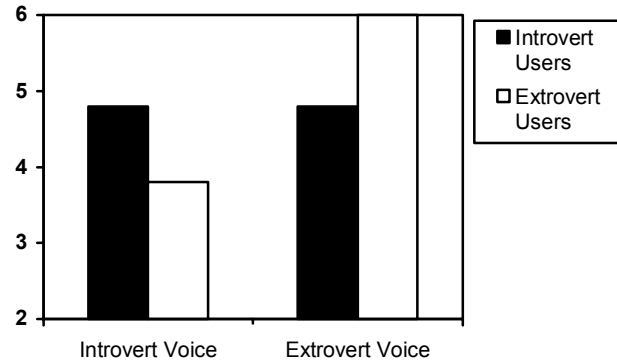


Figure 2. The effect of similarity-attraction on social presence

Hypothesis 2 was also supported: There was a significant cross-over interaction between computer voice personality and text personality for social presence, $F(1, 71) = 11.3, p < .001, \eta^2 = .14$. The introvert voice narrating introvert text ($M = 4.6, S.D. = 1.4$) created greater social presence than when narrating extrovert text ($M = 3.9, S.D. = 1.0$). Conversely, the extrovert voice narrating extrovert text ($M = 6.0, S.D. = 1.2$) induced greater social presence than when narrating introvert text ($M = 4.9, S.D. = 1.7$) (see Figure 3).

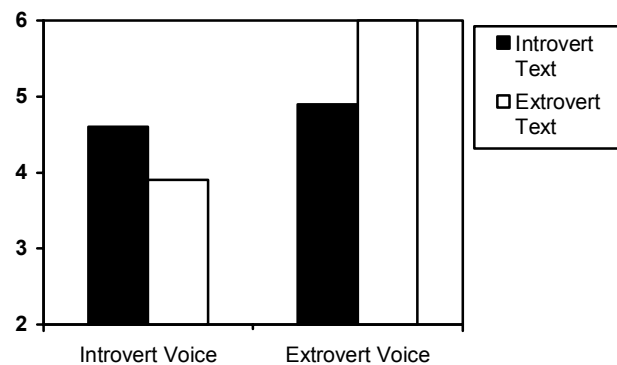


Figure 3. The effect of consistency-attraction on social presence

Consistent with Hypothesis 3, a significant voice main effect was also found, such that the extrovert voice ($M = 5.4, S.D. = 1.5$) produced more feeling of social presence than the introvert voice ($M = 4.3, S.D. = 1.2$), $F(1, 71) = 17.91, p < .001, \eta^2 = .20$. Neither user personality ($F [1, 71] = .17, n.s.$) nor text personality ($F [1, 71] = .73, n.s.$) has a significant main effect on social presence.

Similar to Experiment 1, we did not find any significant effects for gender, $F(1, 71) = 0.83, n.s.$

DISCUSSION

Both Experiment 1 and Experiment 2 provide convincing evidence that people's social responses to media affect their feelings of social presence. In both experiments, users (especially extrovert users) felt stronger social presence when they heard a computer voice manifesting a personality similar to their own than when the voice did not match their personality, even when the voices were clearly synthetic (similarity effect). This result implies that customization of a computer voice according to users' personality will increase feelings of social presence. This result further suggests that media designers should pay particular attention to people's social responses to media, especially when the media manifest various social characteristics on which similarity-attraction might apply, such as gender, ethnicity, and vocation.

There was also a clear evidence in Experiment 2 that consistency between voice personality and text personality was desirable in order to maximize social presence. Of course, this is not news in traditional media: The idea of casting actors, including voice actors, to match their role in order to maximize the social presence of characters is well-established in Hollywood. The present research demonstrates that this same principle carries over to the design of voice-mediated human computer interfaces and VR systems, even when users are constantly reminded that they are not interacting with a person. Despite the clear disfluencies, listeners nonetheless feel more social presence when the voice is consistent with the content. From this context, we can argue that the desire for TTS voice consistency may extend from text content to the role. For example, individuals might feel stronger social presence when stereotypically introverted roles, such as librarian, are represented by an introverted computer voice rather than when they are represented by an extroverted synthesized voice.

Both of the experiments showed that a voice suggesting an extrovert personality induced a greater sense of social presence than a voice that sounded like an introvert. This result implies that artifacts manifesting extrovertedness are more socially present than artifacts manifesting introvertedness in a similar way that human extroverts are more socially present than introverts. Therefore, in a situation when highly socially present virtual actors are desirable (e.g., sales and marketing sites), artifacts should be designed in a way that they clearly manifest extrovertedness. In a situation when clear social presence of virtual actors is detrimental (e.g., privacy sensitive web sites, personal information systems, etc.), interface designers should consider the low social presence (i.e., suggest an introvert).

In both experiments, extroverts were more sensitive to personality-match than introverts. This result implies that the best practice for VUI designers to increase users' feelings of social presence in a situation when they know

neither user personality nor content personality is to use an extroverted voice.

The present research provides strong support for the applicability of social rules and heuristics to the domain of social presence research. Cues of humanness (e.g., language and voice [33, 35] are sufficient to encourage individuals to mindlessly apply social rules when assessing social presence. Despite knowing that computers do not have personality in any human sense, and despite being confronted with a voice that was obviously not human, participants in both Experiment 1 and Experiment 2 applied social categories and heuristics to computer-synthesized voices in assessing the degree of social presence in their media/computer use activities.

Unlike previous studies reporting gender difference in the feelings of presence, we did not find gender differences. One possible reason for the absence of gender differences is that previous research has focused on visual and audio stimuli, while this study focused solely on audio stimuli. Future research should determine if modality interacts with gender.

In sum, the present research suggests that attempts to predict social presence require a more complex and nuanced view than a listing of cognitively-oriented technology differences and user differences. First, research must examine characteristics of technology that implicate *social* rules and heuristics as well as processes of perception and cognition. Second, researchers must examine the *interaction* between technological differences, user differences, and social differences. While this added complexity presents a problem for researchers, it also represents enormous opportunities for theorizing and experimentation.

How ineffective and clearly non-human must an artificial representation be before it no longer is assigned human social characteristics? While this is an open question, the current research suggests that humans have an automatic tendency to be very liberal in assigning humanity to an artificial stimulus as long as they have at least minimal human features and if follow a social rule governing human-to-human interaction. The degree of social presence of an artificial thing, thus, would be governed by its possession of human properties (e.g., language, face shapes, emotion, etc.) and its adoption of human interaction styles (e.g., similarity and consistency rules, etc.).

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