The 2010 IEEE/RSJ International Conference on
Intelligent Robots and Systems
October 18-22, 2010, Taipei, Taiwan

“Could I Have a Word?”: Effects of Robot’s Whisper

Masahiro Shiomi, Kayako Nakagawa, Reo Matsumura, Kazuhiko Shinozawa, Hiroshi Ishiguro, and Norihino Hagita

Abstract—**This paper reports the persuasion effect of a robot’s whispering behavior that consists of a whispering gesture and a request made in a small voice. Whispering gestures naturally make close distance and create warmth feelings with subjects, and requests in quiet voices with whispering gestures also create familiar impressions, which are effective factors of persuasion. We believe that such physical behavior as whispering is one persuasion advantage held by real robots over computers. We conducted a between-subjects experiment to investigate the effectiveness of these two factors on persuasion. In the experiment, the robot requests an annoying task of the subjects; writing as many multiplication table equations as possible. As a result, whispering gestures significantly increased the working time and the number of equations. On the other hand, the loudness of the voice in the request had no effect. We believe the results indicate the effectiveness of physical behavior for persuasion in human-robot interaction.**

I. Introduction

Humans often use non-verbal information, e.g., body gestures, eye contact, facial expressions, and whispers in interaction with others, particularly if requesting or persuading. Much research has focused not only on such physical cues but also on social cues in the field of persuasion known as persuasive technology [1, 2]. The research focus of this field is expanding from human-human interaction to human-computer and human-robot interactions.

What advantage does a real robot have over a computer in persuasion? We believe it is physical existence; in fact, past related works have reported that real robots can affect subject’s decision making more effectively than computer agents in real world information [3]. Moreover, some researchers are using real robots for advertisements in such environments as shopping support [4-6].

However, these works focused on the physical presence and effectiveness of developed robot systems and failed to focus on the detailed physical behavior effects of persuasion. On the other hand, we are investigating how physical behavior affects persuasion in interaction with people. Therefore we focus on a “whispering behavior” (Fig.1) that combines a whispering gesture and a small voice in a request, which is one typical physical queue in the persuasion of human-human interaction that is often observed in conversations between close friends.

Whispering gestures naturally encourage closeness between people and create warmth feelings. Moreover, a small, close voice may also create such feelings. Some past research has reported that nearness and familiar feelings are effective for persuasion [7-9]. Therefore, we believe that such a whispering behavior that combines a whispering gesture and a small voice is very persuasive. Stimulated by this human behavior, we consider whispering behavior one way to increase the effects when our robot is trying to persuade people.

In this paper, we discuss how a whispering gesture in a small voice in a request is effective for persuasion in human-robot interaction. To investigate the whispering behavior’s effectiveness, we conducted a laboratory experiment that involved an annoying task and answered the following questions by a between-subjects experiment in which a robot persuaded subjects with two whispering behavior factors: whispering gesture and loudness.

-Does the whispering gesture of the robot increase the subject's motivation during the annoying task?

-Does a request made by a robot in a small voice increase the subject's motivation to do the annoying task?

Figure 1. Whispering behavior in interaction

Manuscript received February, 28, 2010. This research was supported by the Ministry of Internal Affairs and Communications of Japan.

M. Shiomi, K. Nakagawa, R. Matsumura, K. Shinozawa, H. Ishiguro and N. Hagita are with the Advanced Telecommunications Research Institute International, Kyoto, JAPAN (corresponding author to provide phone: +81-774-95-1432; fax: +81-774-95-1401; e-mail: m-shiomi@atr.jp).

K. Nakagawa, R. Matsumura, and H. Ishiguro are with the Osaka University, Osaka, Japan.

978-1-4244-6676-4/10/$25.00 ©2010 IEEE

II. Related work

In this section, we describe related works on persuasion in human-human interaction and human-robot interaction, particularly nonverbal behaviors. We also discuss why we focused on whisper behaviors in persuasion.

A. Physical existence and robot appearance

In human-human interaction, various kinds of research have investigated such effects of appearance on persuasion as high-status clothing, attractive facial features, and conventional appearance [10-14]. In human-robot interaction, Kanda et al. investigated the differences of physical existence between adults and two kinds of humanoid robots [15]. Some researchers focused on more effective ways for persuasion through interaction. For example, Kidd et al. reported that a robot is more attractive and joyful than a Computer Graphics (CG)-agent and concluded these features are not different between robots and humans [16]. Powers et al. compared a robot and a CG-agent and concluded that the robot is more social, more reliable, and more capable than the CG-agent [17]. Shinozawa et al. compared the effect of recommendation in a laboratory environment between a baby-sized robot and a computer agent displayed on a monitor [3]. Goetz et al. compared the appearances of robot faces and found that a friendly face is appropriate for a playful task [18]. Bainbridge et al. investigated how people respond to a request to throw a book by comparing humans, agents, and robots [19]. From another viewpoint, Siegel et al. reported the effects of robot's gender on persuasion [20].

As shown in the related works, robot appearance is one important factor in persuasion. However, changing a robot's appearance is difficult because its design strongly depends on its functions and such realistic limitations as cost. On the other hand, changing its nonverbal behavior is easier than its appearance. Moreover, nonverbal behavior can easily adapt to other robots with different appearances. Therefore, we believe that focusing on the nonverbal behavior of persuasion is reliable in human-robot interaction.

B. Body gesture and physical distance

Body gesture and changing physical distance are typical examples of nonverbal information. Past researches focused on them for persuasion in the field of human-human interaction. For example, eye contact affects friendliness toward the target in interaction [7, 21]. Other kinds of nonverbal behavior such as a forward-bent posture and proximity effectively create more sympathy in others than verbal information [8, 22]. Others reported that proximity is related to familiarity in interactions [9, 23]. Touching lightly is also effective for persuasion [24-26]

Based on these works, we believe that nearness is effective in persuasion and is one reason we focused on a whispering behavior that encourages nearness in the target to listen to its speech.

C. Speech loudness and speed

McGuire reported that such voice properties as loudness and speed affect persuasion in human-human interactions [27]. Siegman reported that those who speak relatively quickly with short silent pauses are seen as having more favorable attributes than those who speak slower [28]. Pope et al. reported that silent, filled pauses and speech hesitations are negatively correlated with listener attraction to speakers [29].

We are interested in the loudness in near interactions because a robot who talks to a person in a small voice might create friendly impressions as if confiding; one past work reported that confiding by a robot promoted interaction with children [30].

D. Summary of related works

As described in the above related works about human behavior, using such nonverbal information as a whispering gesture and loudness are reliable for persuasion in human-robot interaction. In fact, many researchers suggested the effectiveness of proximity in persuasion, and some reported the effectiveness of such friendly behaviors as touching and confiding. We believe that focusing on the combination of physical distance and voice volume in persuasion in human-robot interactions is the unique point of our research.

III. Methodology

To investigate the effectiveness of a whispering gesture and a request in a small voice, we conducted a laboratory experiment in which we asked participants to converse with ATR's robovie-mR2, a 30-cm tall, humanlike interactive robot whose human-like upper body is designed for communication with humans (Fig. 2). It has the following degrees of freedom: three for its neck, four for each arm, and four for each eye. We used a corpus-based speech synthesis to generate speech [31].

In this section, we describe the following: our interaction design of the robot's whispering behavior, the experimental design, our hypotheses, the experiment procedure, our evaluation measures, and subject profiles.

A. Experimental design

To investigate the effectiveness of a whispering gesture and loudness in a request, we designed a simple scenario in which a robot greets the subject, introduces itself, and explains the annoying task: writing multiplication table equations. We assigned this task to elicit monotonous and boring feelings in the subjects, even though the workload is actually not so high. Determining whether the robot could persuade subjects to do such an annoying task by whispering behavior is useful.

The robot makes the request to the subject with/without a whispering gesture and normal/small voice depending on the condition. The details of the experimental condition are shown in Table 1. In this study, we designed the robot's whisper behavior to stimulate listening behavior from a subject by saying “Could I have a word?” and accompanying both hands to its mouth (Fig. 1). This design reflects the robot’s difficulties of placing its mouth near the subject's ear. Below is the flow of the robot’s conversations and behavior:

Robot: Nice to meet you, I’m robovie-mR2!
Subject: Hello
Robot: I’d like to tell you about this experiment. Please write the multiplication table equations on the paper on that desk (pointing).
Subject: I see.
Robot: Oh, I have a request.
Robot: (by accompanying both arms to its mouth) *1
Robot: Could I have a word? *1
Robot: (Waiting for a request trigger from the operator)
Robot: Please write as many equations as possible. *2
Subject: OK.
Robot: (returning both arms to their home positions) *1
Robot: Please start writing. Let me know when you are finished.
*1: Only conditions 2 and 4.
*2: The robot uses normal volume (around 60 dB) under Conditions 1 and 2. The robot uses small volume (around 30 dB) under Conditions 3 and 4.

We conducted a between-subjects experiment. We did not use speech recognition or a recognition function for the listening behavior of the subjects during the experiment. Instead, the experimenter sent a trigger to the robot so that it made a request to the subject in the Wizard of Oz method [32] (Fig. 3). We manipulated its request timing in four conditions:

In Conditions 1 and 3, the robot did not use the whispering behavior for the request. Two seconds after saying, “Oh, I have a request,” the operator sends a trigger that says, “Please write as many equations as possible.”

In Conditions 2 and 4, the robot uses a whispering behavior for the request. After saying “Could I have a word?,” if the subject bends his/her body toward the robot a couple of seconds after the request, the operator sends a trigger that says, “Please write as many equations as possible.”

B. Hypotheses

We hypothesized that the requests with whispering behavior would increase the number of written equations and the writing time more than requests without the whispering behavior because the whispering behavior would encourage people to feel close to each other and create warm feelings.

Moreover, a combination of the whispering behavior and the request in a small voice would increase the number of written equations and the writing time because requests in a near small voice create warm feelings.

TABLE I
CONDITIONS

	Without whispering behavior	With whispering behavior
Normal volume	Condition 1	Condition 2
Small volume	Condition 3	Condition 4

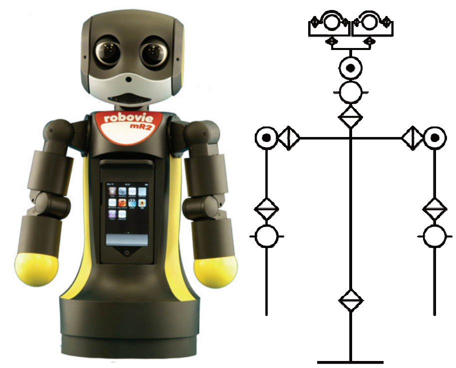

Figure 2. Robovie-mR2: interactive robot

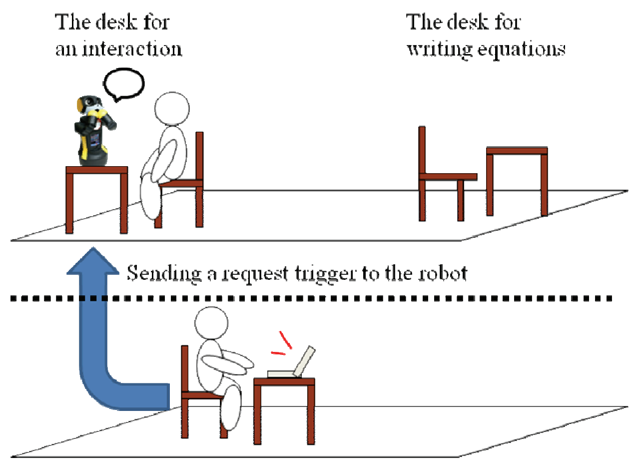

Figure 3. Experimental settings

Based on this consideration, we made the following prediction:

1: Subjects to whom the robot whispers will write more equations and spend more time writing than those to whom the robot failed to whisper.

2: Subjects to whom the robot whispers with a small volume will write more equations and spend more time writing than those to whom the robot whispers with a normal volume.

C. Experiment procedure

Subjects were first given a brief description of the experiment’s purpose and procedure. They were asked to sign a consent form. Subjects were provided with identical instructions and randomly assigned to the experiment conditions. They sat on chairs 75 cm in front of the robot. We based this distance on knowledge of “personal distance,” which is the distance at which acquaintances talk [9]. After interaction with the robot, subjects answered questionnaires.

The task and the experiment procedure averaged five and ten minutes, respectively. The experiment was run in a dedicated space with no outside distractions. An experimenter was present in the space before the experiment, but not during the experiment.

D. Measurement

To evaluate the effects of each factor, we measured the number of written equations and the writing time in seconds. After completing the task, subjects also answered questionnaires that measured their boredom with the task and robot's pronunciation. All items were on a 1-to-7 point scale where seven represents the most positive, four is neutral, and one is the most negative.

E. Participation

A total of 26 university students participated in the experiment. All subjects were native-Japanese-speaking. Subjects were randomly assigned to the experimental conditions: six people for Conditions 1 and 3, and seven for Conditions 2 and 4.

IV. RESULTS

A. Verification of predictions: number of equations and writing time

We analyzed the number of written equations, the writing time, and the questionnaire items using a two-way (whispering x volume) ANOVA. Figs. 4 and 5 show the averages and the standard error (S.E) of each measurement. The results showed a significant difference in the whispering factor (number of equations: $p < .05$, writing time: $p<.05$). Therefore, prediction 1 was supported. In other words, the whispering behavior is effective for persuasion, particularly eliciting motivation to do an annoying task that produces monotony and boredom.

However, there is no significant difference in the volume factor or in the interaction effects. Therefore, prediction 2 was not supported. In other words, the combination of requests in a small voice and whispering behavior did not affect persuasion.

B. Analysis of questionnaires

We conducted manipulation checks by taking the difference between the subject ratings: how boring the task is (Fig. 6) and how indistinct the robot's pronunciation is (Fig. 7). The result of a two-way (whispering x volume) ANOVA revealed no differences, indicating that the whispering behavior and using a small voice did not affect the boredom of the task and the clarity of the robot's pronunciation.

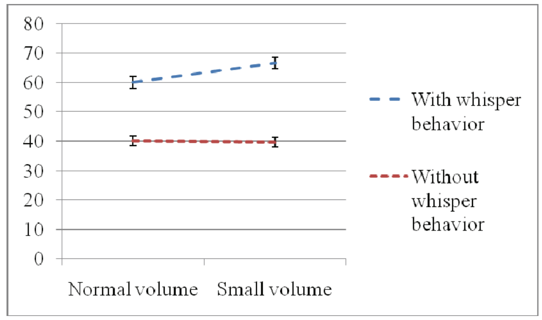

Figure 4. Average and S. E. of number of written equations

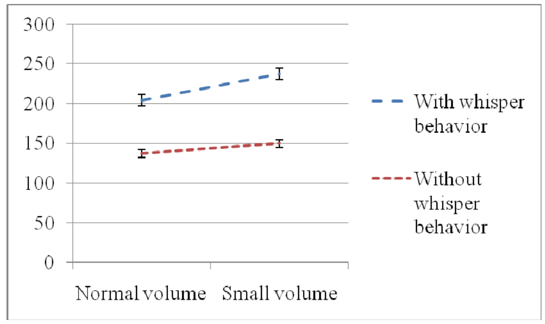

Figure 5. Average and S. E. of writing time (sec)

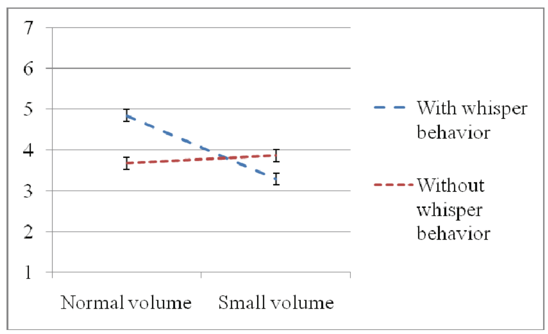

Figure 6. Average and S. E. of boredom

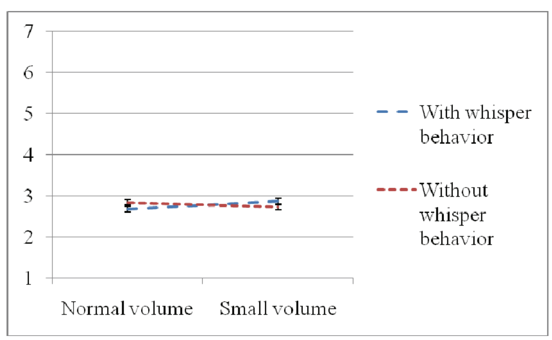

Figure 7. Average and S. E. of clarity of robot's pronounciation

V. DISCUSSION

A. Contribution and implementation of whispering behavior

The number of equations and the writing times were significantly high in the whispering condition although the subjects found the task boring in each condition (the values of all items are around the middle). Furthermore, there was no significant difference for boredom between the conditions, as shown in the manipulations check; the whispering behavior did not increase the boredom of the tasks, even though the subjects spent a long time on them. Therefore, these results suggest that whispering behaviors by robots on persuasion effectively encouraged motivation, so motivation can be applied to various tasks that are important but include monotony and boredom (e. g., homework, rehabilitation, and so on). Moreover, whispering behavior might be useful for such applications in real environments as advertisements. Robots might effectively recommend goods in stores with whispering behavior as sales promotions.

On the other hand, the whispering behavior did not increase the clarity of the robot's pronunciation. Note that although all subjects understood what the robot said in its requests, they gave low evaluations for pronunciation clarity (total average: 2.77). As shown in the results of the manipulation check, neither robot's behavior nor volume differences affected the clarity of the robot pronunciations. Therefore, the reason might reflect the quality of the synthesized voice used in the experiment.

One reason why whispering gestures affect persuasion might be that the behavior elicited a foot-in-the-door effect [33]. The robot makes an easy request, "Could I have a word?" first, so the subject might be receptive to subsequent request: writing equations.

B. *Distance effect for persuasion*

In the experiment, particularly when the robot is whispering, we often observed a scene where a subject leaned forward to listen to the robot's request. Such bending behavior creates nearness between the robot and the subject (Fig. 1) and has been reported to be effective for persuasion [9, 23].

We investigated how whispering gestures encouraged such behavior by classifying the distance between subjects and robots when the robot is whispering into two categories: close distance (0~45 cm) and personal distance (45~120 cm) [9].

Table 2 shows the classification results. A two-way (whispering x volume) ANOVA using the arcsine transformation method indicated significant differences on the whispering factor ($p < .01$). Volume factor and interaction effect were not significant. Therefore, whispering gestures created nearness between robots and subjects.

We also analyzed the number of written equations, the writing time, and the questionnaire items using a one-way (classified distance: near and personal) ANOVA. The results showed a significant difference in the distance factor (p. <01), indicating that nearness is effective for persuasion.

Our results are not so novel because previous research reported the effectiveness of nearness for persuasion [9, 23]; however, we believe that these results also support the effectiveness of whispering gestures for persuasion.

C. *Effect of presence of other persons and volume*

In our experiments, we controlled the volume in the request

TABLE II
DISTANCE CLASSIFICATION WHEN ROBOT IS REQUESTING

	Without whispering behavior		With whispering behavior	
	Normal volume	Small volume	Normal volume	Small volume
Personal distance	5/6	5/7	1/6	0/7
Close distance	1/6	2/7	5/6	7/7

to investigate its effectiveness on persuasion. There was no significant difference in the volume factor, so the latter hypothesis was not supported.

We think there are two main reasons why the volume factor did not affect the persuasion task. First, a "small voice" is not exactly a "whispering voice." A whispering voice indicates not only small but also a breathless voice, which is different from our controlled voice factor. In the future we will make a "whispering voice" and use it in a persuasion experiment to investigate its effectiveness.

The second reason is the absence of a bystander. Whispering behaviors occur in a context of confidence, so the behavior was unnatural in experimental scenes involving only a subject and a robot. A small voice failed to elicit the impression that the "robot is whispering to me." From these considerations, we are also planning to investigate the effects of whispering behavior when a third person exists near the subject.

D. *Limitations*

Since our comparisons are based on a case study with an existing robot, robovie-mR2, the robot generality is limited. We cannot ensure whether the findings can be applied to all interactive robots, particularly unhuman-like robots. However, we believe that the setting is adequate to offer important knowledge for researchers interested in persuasion with interactive robots.

VI. CONCLUSION

In this research, we focused on persuasive technology [1, 2] in the field of human-robot interaction. Physical existence is one of the advantages real robots have over computers in persuasion. To investigate the effectiveness of the physical behavior of the robot and request volume in nearness between a robot and a person for persuasion, we conducted a between-subjects experiment in which a robot persuaded a subject considering two composing factors of whispering behavior: whispering gesture and request loudness. The robot's request is annoying: writing as many multiplication table equations as possible.

The robot's whispering gesture increased the number of equations and the writing time. These results show that whispering gestures are effective for persuasions in human-robot interaction. Physical behavior is one effective way of persuasion in human-robot interaction.

On the other hand, the request loudness did not affect them.

It might be based on the difference between the type of small and whispering voices. In the future, we will experimentally consider such differences to investigate the effectiveness of volume factor on persuasions by adding more subjects. Moreover, another future work possibility is using the emotion expression by the robot's physical movement [34], which is another useful persuasion technique [35], by considering the advantages of physical existence. In addition, comparing with virtual persuasive agents [36] would be important to clearly the effectiveness of an advantage of a physical robot in the context of persuasion.

ACKNOWLEDGMENTS

We wish to thank the following ATR member for her cooperation: Nahoko Sakamaki.

REFERENCES

[1] B. J. Fogg, "Persuasive Technology: Using Computers to Change What We Think and Do," Morgan Kaufmann, 2003

[2] N. Tintarev, J. Masthoff. "A Survey of Explanations in Recommender Systems," Workshop on Recommender Systems and Intelligent User Interfaces associated with ICDE'07

[3] K. Shinozawa, F. Naya, and J. Yamato, "Differences in Effect of Robot and Screen Agent Recommendations of Human Decision-Making," International Journal on Human-Computer Studies, Vol. 62, 2, Feb. 2005.

[4] H. M. Gross, H. J. Boehme, S. Mueller, and A. Koenig, ShopBot: Progress in Developing an Interactive Mobile Shopping Assistant for Everyday Use, IEEE International Conference on System pp. 3471~3478, 2008

[5] M. Shiomi et al., "Field Trial of Networked Social Robots in a Shopping Mall," The 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2009), 2009.

[6] T. Kanda, M. Shiomi, Z. Miyashita, H. Ishiguro, and N. Hagita, An affective guide robot in a shopping mall, *ACM/IEEE International Conference on Human-Robot Interaction (HRI2009)*, 2009.

[7] M. Argyle and J. Dean. Eye contact, distance and affiliation. Sociometry, 28, 289-304, 1965

[8] R. F. Hasse and D. T. Tepper, Nonverbal components of empathic communication, Journal of Counseling Psychology, 19, 417-424, 1972

[9] E. T. Hall, "The Hidden Dimension," Anchor Books, 1990.

[10] L. Bickman, "The effect of social status on the honesty of others," Journal of Social Psychology, 85, 87-92, 1971

[11] L. Bickman, "The social power of a uniform," Journal of Applied Social Psychology, 4, 47-61, 1974

[12] S. Brownlow, and L. A. Zebrowitz, "Facial appearance, gender, and credibility in television commercials," Journal of Nonverbal Behavior, 14, 51-60, 1990.

[13] S. R. Pallak, "Salience of a communicator's physical attractiveness and persuasion: A heuristic versus systematic processing interpretation," Social Cognition, 2, 158-170, 1983.

[14] S. R. Pallak, E. Murroni, and J. Koch, "Communicator effectiveness and expertise, emotional versus rational appeals, and persuasion: A heuristic versus systematic processing interpretation," Social Cognition, 2, 122-141, 1983.

[15] T. Kanda, T. Miyashita, T. Osada, Y. Haikawa, and H. Ishiguro, "Analysis of Humanoid Appearances in Human-robot Interaction," IEEE Transactions on Robotics, 24(3), pp. 725-735, 2008.

[16] C. D. Kidd, and C. Breazeal, Effect of a Robot on User Perceptions. Int. Conf. on Intelligent Robots and Systems, pp. 3559-3564, 2004.

[17] A. Powers, S. Kiesler, S. Fussell, and C. Torrey, Comparing a Computer Agent with a Humanoid Robot. ACM/IEEE Conf. on Human-Robot Interaction (HRI2007), pp. 145-152, 2007

[18] J. Goetz, S. Kiesler, and A. Powers, "Matching robot appearance and behavior to tasks to improve human-robot cooperation," IEEE Workshop on Robot and Human Interactive Communication, 2003

[19] W. A. Bainbridge, J. Hart, E. S. Kim, and B. Scassellati, The Effect of Presence on Human-Robot Interaction, IEEE Int. Symposium on Robot and Human Interactive Communication (RO-MAN2008), pp. 701-706, 2008.

[20] M. Siegel, C. Breazeal, and M. Norton, "Persuasive Robotics: The Influence of Robot Gender on Human Behavior," The 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2009), 2009.

[21] R. V. Exline, "Explorations in the process of person perception: Visual interaction in relation to competition, sex, and need for affiliation," Journal of Personality, 31, 1-20, 1963.

[22] A. Mehrabian, Inference of attitude from the posture, orientation, and distance of a communication. Journal of Counseling and Clinical Psychology, 32, 296-308, 1968

[23] D. Byrne, C. R. Ervin, and J. Lamberth, "Continuity between the experimental study of attraction and real-life computer dating," Journal of Personality and Social Psychology, 16, 157- 165, 1970.

[24] J. Brockner, B. Pressman, J. Cabitt, and P. Moran, "Nonverbal intimacy, sex, and compliance: A field study," Journal of Nonverbal Behavior, 6, 253-258, 1982.

[25] Goldman, M., Kiyohara, O., and Pfannensteil, D. A. (1984). Interpersonal touch, social labeling, and the foot-in-the-door effect. Journal of Social Psychology, 125, 143-147.

[26] R. Kurklen, and H. Kassinove, "Effects of profanity, touch, and subjects' religiosity on perceptions of a psychologist and behavioral compliance," Journal of Social Psychology, 131, 899-901, 1991.

[27] W. J. McGuire, "Attitudes and attitude change," In G. Lindzey and E. Aronson (Eds.), Handbook of social psychology (3rd Ed., Vol. 2, pp. 233-346). New York: Random House, 1985.

[28] A.W. Siegman, "The telltale voice: Nonverbal messages of verbal communication," In A. W. Siegman and S. Feldstein (Eds.), Nonverbal behaviors and communication (2nd ed., pp. 351-434). Hillsdale, NJ: Lawrence Erlbaum, 1987.

[29] B. Pope, and A. W. Siegman, "Ambiguity and verbal fluency in the TAT," Journal of Consulting Psychology, 30, 239-245, 1966.

[30] T. Kanda, R. Sato, N. Saiwaki, and H. Ishiguro, "Friendly social robot that understands human's friendly relationships," IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS2004), pp. 2215--2222, 2004.

[31] H. Kawai, T. Toda, J. Ni, M. Tsuzaki, and K. Tokuda, "XIMERA: "A New TTS from ATR Based on Corpus-Based Technologies," Proc. of Fifth ISCA Workshop on Speech Synthesis (SSW5), pp. 179-184, 2004

[32] D. Dahlback, A. Jonsson, and L. Ahrenberg. "Wizard of Oz studies-why and how," Knowledge based systems, vol. 6, no. 4, pp. 258~266, 1993

[33] J. Freedman, and S. Fraser, "Compliance without pressure: The foot-in-the-door technique," Journal of Personality and Social Psychology, 4, 195-202, 1966

[34] K. Nakagawa et al., "Motion Modification Method to Control Affective Nuances for Robots," The 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2009), 2009.

[35] E. Berscheid and H. T., Reis, "Attraction and close relationships," In D. T. Gilbert, S. T. Fiske, and G. Lindzey (Eds.), the handbook of social psychology (4th ed., pp. 193-281). New York: Oxford University Press.

[36] Hideyuki Nakanishi, Shinya Shimizu and Katherine Isbister, "Sensitizing Social Agents for Virtual Training," Applied Artificial Intelligence, Vol. 19, No. 3-4, pp. 341-361, 2005.