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Active or Passive?: Investigating the impact of Robot Role in Meetings

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Abstract— **Meetings are an integral part of the work place and society in general. Research in Computer Supported Cooperative Work attempts to facilitate and make the process of meetings more effective. Our vision is that the incorporation of social robots in such human-human collaborative settings can assist and improve the effectiveness of a meeting. In this paper we present an empirical study in which pairs of participants collaborate in a meeting scenario with a Nao humanoid robot. Using a within-subjects design, we manipulated the robot's role within the meeting as being either "active" versus "passive"/"service-oriented". Our results show that the more active robot was deemed as more more alive and social, had the participants more emotionally involved and caused more verbal engagement from the participants as compared to a passive service robot. In conclusion, we speculate on the inclusion of a collaborative robot as a meeting partner.**

I. INTRODUCTION

Social robots are beginning to permeate our society at a rapid pace [1], across a variety of areas [2], such as education, health, etc. One domain in Human Robot Interaction (HRI) where robots (we use robots and humanoids interchangeably in this paper) have been under utilized is that of multi-user collaborative scenarios such as meetings, given that most if not all meetings have some forms of technology embedded in them. The value of integrating technology in multi-user scenarios is largely a resolved debate, with the benefits of groupware well understood [3], [4] and the positive impact of technology in meetings advocated by not only researchers [5] but also the participants of the meeting themselves [6]. The Computer Supported Cooperative Work (CSCW) conference discusses the integration of technology in group settings and is an established venue [7] with the 2013 edition attracting more than 600 attendees. Extrapolating from the impact of other technologies on CSCW research one can assume that social robots would have a positive effect too, given that robots have not only most capabilities of other computing devices but also an embodiment.

The productivity provided by a virtual agent in multi-user settings in comparison to human only groups was already established in 2000 [8]. A social robot could therefore be just as valuable in collaborative scenarios. Our grand vision is that a humanoid robot with intelligent access to information (including Internet), communication and mediation skills, can be a much needed and effective partner in meetings. In summary, besides having the potential of being a mobile device and an information display wrapped in one, robots could also have a strong presence effect via their physical embodiment. The purpose of our study has been to address a potentially interesting debate before we incorporate robots in meetings; i.e. how do humans perceive the involvement of robots based on what role the robots take. Therefore, the goal of this pilot project was to conduct an interaction experiment where the relative effectiveness of two varying robot roles in meetings was inferred from meeting outcomes and human behavior, such as the number of participant-robot interactions, as well as ratings of the experience of interacting with the robot.

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II. BACKGROUND

Meetings are defined as a setting where humans sit together and traverse through an exchange or flow of information [9]. The process of conducting a meeting is quite complex and by the intervention of technology in meetings there is an option to optimise the efficiency by automating certain aspects of the process. With the continuous advancement of technology and digital media, it is not of surprise that state of the art devices/artifacts have become a part of meetings. Video-conferencing facilities, interactive displays and shared boards are now an almost basic necessity of any organisation. Upon analyzing relevant literature in Human Computer Interaction (HCI) and Computer Supported Collaborative Work (CSCW) we can broadly identify three main types of technologies that are widely researched within the domain of meetings.

A. Mobile Devices

With the rapid growth in availability of smart phones and cheaper bandwidth, research in Mobile HCI has witnessed a strong integration of mobile phones in meetings. Perhaps the most cited work in this area is the Interactive Workspace Project [10], where the concept of a mobile enabled shared display is introduced. More recent examples include the Ubijector [11], where a system superimposes each individual screen of mobile devices in a meeting.

B. Tabletops

Most if not all meetings are held around a table of some sort. A seamless integration of technology could very simply be made possible by making the table come alive i.e. the area of Tabletop technology [12]. An example of tabletops supporting the flow of meetings is that of the Reflect Table [13], where color representations at each corner of the table

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are used to map the amount of verbal articulations by the participant in that corner.

C. Virtual Avatars

One other stream of the incorporation of technology into meeting scenarios is that of virtual avatars used as telepresence agents. The work of Nijholt [14], provides various application scenarios in which virtual avatars are used in not only real meetings but also in simulated virtual worlds.

After studying relevant literature in the area of supporting meetings with the intervention of technology, one clear gap emerges, i.e. employing the use of social robots or humanoids. There have been some inklings in previous research focusing on the notion of involving robots as a cohort in meetings. Prior work has studied the use of a robot in a meeting as video conferencing tool [15], however the robot employed was a virtual avatar. Other research has focused on the architectural framework and technical underpinnings of a CSCW system that utilises a robot [16]. Other projects have looked into the face and gaze tracking modules of a humanoid robot [17] to facilitate group conversations by simplifying aspects such as turn taking and addressee identification. A similar endeavour in HRI utilises sound localisation and an efficient dialog manager to act as a referee in a rock, paper and scissors game [18]. However looking at the relevant prior work overall, a treatment of how a robot should behave in group conversations and meetings and if indeed humans are accepting its participation is left unaddressed. In order to establish what contribution is accepted from the robot it is imperative to contemplate what role is desired from a robot in a meeting, i.e. either as an active team player or as a passive service providing agent.

Our taxonomy of robot roles was grounded by adopting the Functional Role Coding Scheme (FRCS) [19] which describes typical roles that human particpants may take in meetings under two main categories: Task and Socio-Emotional. In this paper we only focus on the Task domain and consequently the functional aspects of robot behaviour and not on any emotional responses of the robot. Thereafter, we mapped the two robot roles to the two extremes within the Task domain, namely: Orienteer and Follower. The orienteer (hence the more active participant) "chairs" the group, keeps the group on track and facilitates discussion. The follower (the more passive participant) mostly listens without much active participation.

Humans would either want a robot to provide function and service whenever prompted and remain silent otherwise; or to be an initiative-taking team member of the decision making process. A service robot would thereby operate as any other technological device, running in the background and available for information extraction when requested or prompted. In addition our categorisation of robot roles would be akin to describing the personality of the robot as extrovert or introvert, as suggested in the study [20], where participants confirmed that they were attributing robot personality based on whether the robot was a companion or a service provider. Categorization of robot personality is a commonly studied area in HRI [21], where it was shown that humans preferred the extrovert robot in the context of one on one human robot interactions. Similarly in a study [22] that investigated the gaze following behaviour of infants in response to robot behaviour, it was found that the infants gazed at an active robot more often than a passive robot. Although user preference would tend to align towards robots that are more active, passive and service behavior in robots has found to lead to better outcomes and task success [23].

All of the afore-mentioned explorations have been carried out in single user-robot interactions. There is growing recognition of the importance of studying the integration of robots in multi-user social settings such as educational scenarios [24]. Therefore, our research question aims to dissect and determine the impact of active and passive robot role in multi-user robot interactions such as meetings, i.e. if robot role or amount of interaction makes a difference to HRI in multi-user scenarios and humans prefer activity to passivity would then an active/orienteer-type robot be more positively evaluated, and lead to a greater number of verbal interactions, and task success than a service/follower robot?

III. Method

We conducted a within subjects study where a pair of human participants and a humanoid robot worked on a collaborative task. The role of the robot was either active/orienteer-type or service-oriented/follower-type. Participants interacted with both robot roles and therefore took part in two different sessions in order to solve two unique instances of the same task. The order of the two roles was counter balanced. Ethics clearances were received from the host institution (Ref:H10419) prior to conducting the experiment.

A. Procedure

Every pair of participants was invited to the experiment room. After welcoming the participants, the facilitator explained the goal of the research as to investigate the impact of humanoid robots in meetings and nothing further was stated about the goal of the experiment. The humanoid robot was introduced as a team member of the two participants. Thereafter the experiment task was summarised which was the hidden profile exercise from social psychology [25]. In this task, each member of the team is provided with a list of attributes of three hypothetical job candidates (for e.g. lecturer 1, 2 and 3) and as members of a selection panel the team must arrive at a consensus of the most suitable candidate. However, every group member is provided with a slightly different (not contradictory) list of positive, negative and neutral attributes of each candidate such that some of the attributes are unshared in a biased way. In order to arrive at the "right" answer (i.e. selecting the candidate with the least negative attributes) the participants must discuss the attributes and share the information amongst each other. The participants were informed that the robot also had a list of attributes about the three candidates that were "fed" in its memory. In order to explain the dynamics of the hidden profile task the participants were conveyed the following: *"All information is the truth and the three of you do not have contradicting information. Also, the three of you may not have identical information. Feel free to interact amongst yourselves and the robot to reach the best decision."* The participants were then requested to provide consent for video recording, after which the facilitator left the lab and the first session started. Each session first began with 2 minutes of reading time in which the participants were supposed to read their list of attributes. They were then provided with 5 minutes of discussion time in which they freely interacted amongst each other and the humanoid robot. The participants were informed at the start of the session that they would have 2 minutes of reading time and 5 minutes of discussion time. At the end of the 5 minutes they would need to arrive at a final answer. The facilitator would then enter the experiment room and both participants were requested to fill in a survey regarding their experiences in the session. The second session would commence shortly thereafter in which the participants would get a new list of attributes regarding another set of candidates. On conclusion of the second session, the participants would yet again fill in the survey (but this time in reference to their experience in the second session), after which the facilitator would thank the participants and guide them towards the exit.

B. Manipulation of Robot Behaviour

The humanoid robot employed for the experiment was the Nao robot from Aldeberan Robotics and its behaviour was controlled by wizard of oz setup. The role of the robot was either as an orienteer or a follower as per the FRCS [19]. The orienteer robot was more dynamic and interactive. For e.g. the more active robot would remind the participants that success would lie in sharing the information on the sheets and it would offer to share the attributes that it had in its memory. It would also motivate the participants on the importance of reaching a decision within 5 minutes and would also break any prolonged silence in the discussion. However, the follower/service/passive robot would only interact or share its list of attributes when prompted/requested by either of the human participants and would not remind the participants that the list of attributes may be shared. It would only reveal the time left when asked. Neither the collaborative or service robot would give a clear indication of the preferred candidate. For both conditions, the robot would only talk but not move physically and it was seated with its legs spread out in front. Given is a table (see Table I) which presents some of the variations in the dialog structure across the two conditions.

C. Setup

The two participants and the Nao robot were seated in a triangular fashion with the robot at the top vertex, such that the participants were equidistant from the robot (see Figure 1). A video camera was placed in discrete manner that would record the events as they unfolded. The wizard was located in another room and could monitor the audio and video feed of the session. The participants were oblivious of the presence of a wizard.

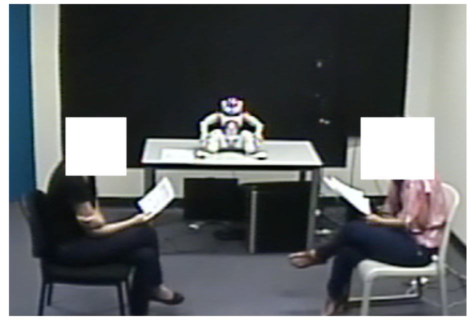

Fig. 1. Experiment Setup

Item	Z	p
Engagement	-1.27	0.20
Closer to Reality	-1.85	0.06
Alive	-1.56	0.12
Social	-1.78	0.08
Responsive	-1.5	0.14
Emotional Involvement	-2.87	*0.004
Control over Interaction	-1.4	0.16
Friendly	-1.51	0.13

TABLE II
QUESTIONNAIRE RESULTS

D. Measurements

Measurements included the Robot Interactive Experiences Questionnaire [26] comprising of 7 point likert items about the interactive experience with a robot. Other measurements included task success and session videos were coded to determine the number of verbal articulations by each participant.

E. Participants

16 (10 female) participants were voluntarily recruited from within the host institution. Their participation was rewarded with a $20 gift card.

IV. RESULTS

We now describe quantitative results obtained across each of the measurements.

A. Questionnaire

We do not list all items of the questionnaire but present the ones of interest (significant or nearing significance) (see Table II). Wilcoxon Signed Rank Test was used to analyze the data. In general, most of the items depicted that the participants preferred the active robot over the service robot. The participants felt the active or orienteer robot was more engaging, closer to reality (nearing significance), more alive, more social (nearing significance), more responsive, had them emotionally involved (significant), provided them with more control over the interaction and was more friendly.

Time, In Response To or Event Occurred	Dialog by the Robot	Service	Active
Start of Discussion	I have read the profile of the candidates. It is a difficult choice but I think we should closely consider and evaluate the pros and cons of all the candidates. Remember all of us have different sheets. What do you guys think?	No	Yes
When asked how much time left at x mins	We have 5-x minutes left	Yes	Yes
What do you think "robot"/What do you think about candidate X robot	I do not know but I am sure you can reach the best decision	Yes	No
What do you think "robot"/What do you think about candidate X robot	I am still contemplating, but as mentioned prior, we should closely consider the pros and cons of each candidate and share the information amongst each other. Should I tell you the attributes that I have for Candidate X?	No	Yes
Robot, can you list the attributes of candidate X	The attributes that I have in the profile for candidate X are...	Yes	Yes
4 mins	We need to reach to a consensus now, What is our final decision?	No	Yes
Prolonged Silence of more than 20 seconds in the session	Are you confused? Let us closely discuss and match the attributes on our sheets against each other, that might help us to make an informed decision	No	Yes
When the robot has not said anything for 30 seconds	We are doing a great job	No	Yes

TABLE I
DIALOG STRUCTURE ACROSS THE TWO ROBOT ROLES

B. Task Success

A Mann Whitney Test showed that task success was better, although not significantly with the active robot Z=-1.44, p=0.15 as compared to the passive robot. In four of the eight sessions with the active robot the right answer was attained and only once with the service robot.

C. Verbal Articulations

Session videos were analysed and verbal articulations of human participants were coded. As per [27], a new vocalisation was triggered if there was a pause of greater than 2 seconds, or separated by a non-speech sound or robot sound or speech by the other participant. At any given instance the addressee was either the other human participant or the Nao robot which was governed by eye contact, as indicated in research on addressee identification [28]. A similar model has been followed in prior HRI research, where in multi-user interactions, the robot utilises gaze tracking to determine the main participant; all other users are categorised as observers [29]. In our coding scheme, if eye contact would not be made then the addressee was determined by who spoke immediately prior, under the assumption that a "dialogue" was taking place [28]. Non-verbal articulations and semantics were not coded. Only discussion time was coded and not reading time. Every participant was coded separately for each session using the ELAN software, which therefore provided with four measurements: duration and frequency of talking to the other human participant and to the Nao robot. The video from two sessions (4 participants) was not considered due to an error in the recordings. Author 1 coded all the videos and Author 3 coded 20% of the videos. Inter-rater reliability was computed as suggested in [30], as the analysis of verbal interaction in videos involves the coding of non-discrete events. Cohen's Kappa was found to be 0.5 and 0.62 for the two addressee's which indicates moderate reliability [31]. Wilcoxon Signed Rank Test showed that the frequency of talking to the active robot was more (nearing significance) than the service robot Z=-1.85,p=0.06 and the duration of the verbal interactions to the active robot was significantly more than the service robot Z=-1.99,p=0.04 (see Table IV). The duration of speech between participants was more when the robot took on the service role Z=-1.27,p=0.20, whereas the frequency of speech between participants was not significant Z=-0.61,p=0.54 (see Table III). Session order did not have a significant effect on the verbal articulations.

Measure	Service	Collab.
Duration (seconds)	79.7 (40.7)	61.3 (38.4)
Frequency	10.1 (4.9)	11.2 (3.6)

TABLE III
MEAN WITH STD DEVS IN BRACKETS - TALKING TO PARTICIPANT

Measure	Service	Collab.
Duration (seconds)	8.9 (8.1)	14.5 (15.6)
Frequency	3.1 (2.3)	5.2 (3.5)

TABLE IV
MEAN WITH STD DEVS IN BRACKETS - TALKING TO NAO

V. DISCUSSION

Our study has shown that a more active, interactive, extrovert and orienteer robot as a partner in meetings was positively evaluated on some questionnaire items and led to more verbal involvement as compared to a passive robot. Therefore, our results cast a promising outlook on a possible incorporation of robots in meetings. We can foresee that humans would be willing to engage, interact and even receive guidance from a robot in the form of a collaborative team partner, a possibility that is also supported by [32] where people expressed positivity with regards to working with robots. We can speculate on the various applications that a collaborative robot could be part of. The humanoid could be applied as a co-designer, supporting brainstorming and even drawing tasks [33] in a meeting scenario. Group dynamic monitoring systems such as [34] could provide complementary data to drive the behaviour of the robot. Groupware systems can also track gaze and verbal patterns of users in meeting scenarios [35], the output of which could determine robot behaviour, especially in the role of an orienteer or collaborator where the robot must detect aspects such as unequal participation. Our results also portray that the Nao was talked to less as compared to the other participant, which is fine as *we do not intend that the robot replace a human but rather function as an active assistant*, a thought shared in HRI [36]. We did not attain significant results for Task Success, so we cannot confirm or disprove the implication that a passive or service robot would lead to better task success as suggested in [23]. Further data collection may provide with an answer but general compliance with a robot is probably dictated by deeper underlying factors such as the age of participants, experience with robots, novelty effects, perception of being in or under control etc. In general, we have observed that evaluating the integration of robots in multi-user settings is a complex research area and further investigations on robot behaviour pertaining to its emotional and physical involvement (such as voice, pitch - manipulation of which is described in [37], gaze patterns) are necessary. A static emotionless team participant (as the Nao was in the experiment described in this paper) would probably not be realistic.

A. Limitations

Although our initial results are interesting, they must be interpreted cautiously as our sample size is currently small. We also did not measure the relationship between the two participants nor did we measure the personality of each individual participant. The personality of a human user has shown to influence the perception of robot behavior and personality [38]. In addition, we did not investigate the productivity and impact of including a robot in a multi-user setting by comparing with a control condition comprising of only human participants. As stated prior, our perception is that, such a comparison is not necessary given the largely seamless integration of other forms of technology in group and multi-user settings. It may also be possible that a human only triad setting would attain similar results but the goal of our study has been to understand what role could be attributed to a social robot in a meeting scenario. Moreover, in this study we only report on two extreme robot roles within the Task domain of the FRCS scheme [19]. Several other roles are listed which are worth of exploration.

VI. Future Work

As part of our future work, besides collecting more data (both quantitative and qualitative) we aim to delve into further analysis of the videos from the sessions by coding variables such as looking at behaviour of the participants, the quality of the decision making process (as suggested in [39]) and the semantic content of the verbal articulations. By analysing the semantics of the articulations we can also code

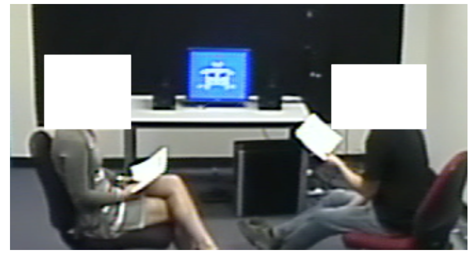

Fig. 2. Experiment Setup for the Virtual Nao

articulations which may have been intended to the whole group. Moreover, we also aim to extend the experimental setup by adding another independent variable by utilising a virtual representation of the Nao. We have conducted initial pilots of our virtual agent setup (see Figure 2). Consequently, we will be able to measure the presence effect of a humanoid robot over a virtual agent in a multi-user collaborative scenario. Such a setup will then be able to answer a much more broader research question pertaining to the added value of an embodied agent/robot over other conventional modes of technology such as remote screeens or virtual agents.

References

[1] S. D. IFR, "World robotics survey," Tech. Rep., 2012.

[2] M. A. Goodrich and A. C. Schultz, "Human-robot interaction: a survey," *Foundations and Trends in Human-Computer Interaction*, vol. 1, no. 3, pp. 203–275, 2007.

[3] J. Grudin and S. E. Poltrock, "Taxonomy and theory in computer supported cooperative work," *The Oxford Handbook of Industrial and Organizational Psychology. Oxford University Press, New York*, 2012.

[4] A. Divoli, D. Potena, C. Diamantini, and W. W. Smari, "Editorial: Special issue on advances in computer supported collaboration: Systems and technologies," *Future Generation Computer Systems*, vol. 31, pp. 105–110, 2014.

[5] R. Rienks, A. Nijholt, and P. Barthelmess, "Pro-active meeting assistants: attention please!" *Ai & Society*, vol. 23, no. 2, pp. 213–231, 2009.

[6] M. Brandon, S. Epskamp, T. de Groot, T. Franssen, B. van Gennep, and T. Visser, "The effects visual feedback on social behavior during decision making meetings," in *Human Interface and the Management of Information. Interacting with Information*. Springer, 2011, pp. 219–228.

[7] M. Jacovi, V. Soroka, G. Gilboa-Freedman, S. Ur, E. Shahar, and N. Marmasse, "The chasms of cscw: a citation graph analysis of the cscw conference," in *Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work*. ACM, 2006, pp. 289–298.

[8] K. Isbister, H. Nakanishi, T. Ishida, and C. Nass, "Helper agent: designing an assistant for human-human interaction in a virtual meeting space," in *Proceedings of the SIGCHI conference on Human factors in computing systems*. ACM, 2000, pp. 57–64.

[9] R. Rienks, A. Nijholt, D. Reidsma, and H. M. I. HMI, "Meetings and meeting support in ambient intelligence," 2006.

[10] B. Johanson, A. Fox, and T. Winograd, "The interactive workspaces project: Experiences with ubiquitous computing rooms," *Pervasive Computing, IEEE*, vol. 1, no. 2, pp. 67–74, 2002.

[11] H. Lim, S. Choi, and J. Lee, "Ubi-jector: an information-sharing screen in a casual meeting environment using mobile devices," in *CHI'13 Extended Abstracts*. ACM, 2013, pp. 1695–1700.

[12] R. Martínez, A. Collins, J. Kay, and K. Yacef, "Who did what? who said that?: Collaid: an environment for capturing traces of collaborative learning at the tabletop," in *Conference on Interactive Tabletops and Surfaces*. ACM, 2011, pp. 172–181.

[13] K. Bachour, F. Kaplan, and P. Dillenbourg, "Reflect: An interactive table for regulating face-to-face collaborative learning," in *Technologies Across Learning Contexts*. Springer, 2008, pp. 39–48.

[14] A. Nijholt, J. Zwiers, and J. Peciva, “Mixed reality participants in smart meeting rooms and smart home environments,” *Personal and Ubiquitous Computing*, vol. 13, no. 1, pp. 85–94, 2009.
[15] M. Nuttin, D. Vanhooydonck, E. Demeester, H. Van Brussel, K. Buijsse, L. Desimpelaere, P. Ramon, and T. Verschelden, “A robotic assistant for ambient intelligent meeting rooms,” in *Ambient Intelligence*. Springer, 2003, pp. 304–317.
[16] W. Li and M. Hu, “A framework for computer supported cooperative work in design with robots,” in *Conference on CSCW in Design*. IEEE, 2005, pp. 783–786.
[17] Y. Matsusaka, T. Tojo, S. Kubota, K. Furukawa, D. Tamiya, K. Hayata, Y. Nakano, and T. Kobayashi, “Multi-person conversation via multimodal interface-a robot who communicate with multi-user-.” in *EUROSPEECH*, vol. 99, 1999, pp. 1723–1726.
[18] K. Nakadai, S. Yamamoto, H. G. Okuno, H. Nakajima, Y. Hasegawa, and H. Tsujino, “A robot referee for rock-paper-scissors sound games,” in *Robotics and Automation, 2008. ICRA 2008. IEEE International Conference on*. IEEE, 2008, pp. 3469–3474.
[19] B. Lepri, A. Mani, A. Pentland, and F. Pianesi, “Honest signals in the recognition of functional relational roles in meetings,” in *AAAI Spring Symposium: Human Behavior Modeling*, 2009, pp. 31–36.
[20] M. Brandon, “Effect personality matching on robot acceptance: effect of robot-user personality matching on the acceptance of domestic assistant robots for elderly,” 2012.
[21] M. Lohse, M. Hanheide, B. Wrede, M. L. Walters, K. L. Koay, D. S. Syrdal, A. Green, H. Huttenrauch, K. Dautenhahn, G. Sagerer, *et al.*, “Evaluating extrovert and introvert behaviour of a domestic robota video study,” in *Robot and Human Interactive Communication, 2008. RO-MAN 2008. The 17th IEEE International Symposium on*. IEEE, 2008, pp. 488–493.
[22] A. N. Meltzoff, R. Brooks, A. P. Shon, and R. P. Rao, “social robots are psychological agents for infants: A test of gaze following,” *Neural Networks*, vol. 23, no. 8, pp. 966–972, 2010.
[23] F. Wille, A. Berthoud, K. Franinovic, F. Mondada, S. Lemaignan, P. Dillenbourg, P. Rétornaz, J. Fink, F. C. Vaussard, *et al.*, “Which robot behavior can motivate children to tidy up their toys? design and evaluation of” ranger”,” in *9th ACM/IEEE International Conference on Human-Robot Interaction (HRI” 14)*, 2014.
[24] T. Kanda, T. Hirano, D. Eaton, and H. Ishiguro, “Interactive robots as social partners and peer tutors for children: A field trial,” *Human-computer interaction*, vol. 19, no. 1, pp. 61–84, 2004.
[25] T. Greitemeyer and S. Schulz-Hardt, “Preference-consistent evaluation of information in the hidden profile paradigm: beyond group-level explanations for the dominance of shared information in group decisions.” *Journal of personality and social psychology*, vol. 84, no. 2, pp. 322–339, 2003.
[26] C. D. Kidd and C. Breazeal, “Effect of a robot on user perceptions,” in *Conference on Intelligent Robots and Systems*, vol. 4. IEEE, 2004, pp. 3559–3564.
[27] J. Hailpern, K. Karahalios, J. Halle, L. Dethorne, and M.-K. Coletto, “A3: Hci coding guideline for research using video annotation to assess behavior of nonverbal subjects with computer-based intervention,” *ACM Transactions on Accessible Computing*, vol. 2, no. 2, pp. 8–29, 2009.
[28] N. Jovanovic, R. op den Akker, and A. Nijholt, “Addressee identification in face-to-face meetings.” in *EACL*, 2006, pp. 169–176.
[29] Y. Matsusaka, S. Fujie, and T. Kobayashi, “Modeling of conversational strategy for the robot participating in the group conversation.” in *INTERSPEECH*, vol. 1, 2001, pp. 2173–2176.
[30] L. A. Penner, H. Orom, T. L. Albrecht, M. M. Franks, T. S. Foster, and J. C. Ruckdeschel, “Camera-related behaviors during video recorded medical interactions,” *Journal of Nonverbal Behavior*, vol. 31, no. 2, pp. 99–117, 2007.
[31] J. R. Landis and G. G. Koch, “The measurement of observer agreement for categorical data,” *biometrics*, pp. 159–174, 1977.
[32] L. Takayama, W. Ju, and C. Nass, “Beyond dirty, dangerous and dull: what everyday people think robots should do,” in *HRI*. ACM, 2008, pp. 25–32.
[33] O. St-Cyr, Y. Lespérance, and W. Stuerzlinger, “An intelligent assistant for computer-aided design,” in *Smart Graphics: AAAI Spring Symposium*, 2000, pp. 24–28.
[34] T. Kim, A. Chang, L. Holland, and A. S. Pentland, “Meeting mediator: enhancing group collaborationusing sociometric feedback,” in *Conference on CSCW*. ACM, 2008, pp. 457–466.
[35] S. Al Moubayed, J. Edlund, and J. Gustafson, “Analysis of gaze and speech patterns in three-party quiz game interaction,” *Interspeech, Lyon, France*, 2013.
[36] K. Dautenhahn, S. Woods, C. Kaouri, M. L. Walters, K. L. Koay, and I. Werry, “What is a robot companion-friend, assistant or butler?” in *Conference on Intelligent Robots and Systems*. IEEE, 2005, pp. 1192–1197.
[37] K. M. Lee, W. Peng, S.-A. Jin, and C. Yan, “Can robots manifest personality?: An empirical test of personality recognition, social responses, and social presence in human–robot interaction,” *Journal of communication*, vol. 56, no. 4, pp. 754–772, 2006.
[38] M. L. Walters, D. S. Syrdal, K. Dautenhahn, R. Te Boekhorst, and K. L. Koay, “Avoiding the uncanny valley: robot appearance, personality and consistency of behavior in an attention-seeking home scenario for a robot companion,” *Autonomous Robots*, vol. 24, no. 2, pp. 159–178, 2008.
[39] S. R. Hiltz, K. Johnson, and M. Turoff, “Experiments in group decision making communication process and outcome in face-to-face versus computerized conferences,” *Human communication research*, vol. 13, no. 2, pp. 225–252, 1986.