Social Communicative Effects of a Virtual Program Guide

Nicole C. Krämer

Department of Psychology, University of Cologne, Bernhard-Feilchenfeld-Str. 11, 50969 Köln, Germany
nicole.kraemer@uni-koeln.de
http://www.uni-koeln.de/phil-fak/psych/diff/dafmitarb.htm

Abstract. Embodied interface agents are considered to be a promising interface metaphor of the future since they are widely expected to facilitate HCI and trigger natural communication. Although first evaluations indicate that virtual characters have various strong effects, it is still unknown if and how embodied conversational agents affect the way in which users communicate with the technological system. An experimental study was conducted to analyze if users interact differently when confronted with different kinds of interfaces (GUI, speech output, embodied interface agent) of a TV-VCR-System. 65 participants were asked to solve different tasks choosing either natural speech or remote control as input devices. Results show that a system is significantly more often addressed by natural speech when an embodied interface agent is visible. Additional qualitative analyses of the semantic content of all 943 speech acts indicate that users seem to have a more human-like attitude and behavior towards the system when it is represented by an anthropomorphic agent.

1 Introduction

Embodied interface agents are considered to be the interface of the future since they are supposed to ease human-computer-interaction [1, 2]. The expected relief is due to the fact that the anthropomorphic, i.e. human-like characters interact on the basis of rules that are similar to a human-like face-to-face-interaction. This should facilitate interaction since people are accustomed to this form of interaction - even novices or the elderly should be able to handle computers and electronic devices easily. DeLaere, Lundgren and Howe [3] term this the "dialog partner" metaphor and state: "…interface designs which incorporate elements that evoke or simulate human social interaction should result in more natural and infomative user-system communications" (p. 44). But empirical results demonstrating the general effects and specific benefits concerning communicative reactions of the user are still scarce.

In particular, embodied interface agents have not yet been shown to actually ease the communication process between human beings and machines, e.g., by inviting intuitive interaction. The study that will be presented here contributes to this area by analyzing how people react to different kinds of interfaces. It focuses on possible advantages and drawbacks of the virtual characters in terms of their ability to affect the users´ input behavior. In addition to these applied research aspects, basic research

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issues are considered by discussing and investigating the question whether interactions between user and interface agent reveal social attitudes [4, 5].

Effects of embodied interface agents can be termed 'social' if a participant's emotional, cognitive, or behavioral reactions are similar to reactions shown during interactions with other human beings. A number of studies show that those – actually inappropriate - reactions really do occur, sometimes even without the appearance of a human-like character. Even technological systems such as computers can evoke social reactions [5]. Various studies [6, 7, 8] indicate that in interactions with computers a) politeness phrases are employed, b) principles of person perception and gender stereotypes apply, and c) liking is triggered in a similar way as within human relationships (computer that 'flatter' and give positive feedback are evaluated more positive). Consequently, Nass et al. [8] postulate that a "rich human presentation" in the sense of e.g. embodied interface agents is not necessary to evoke social reactions. However, both their theoretical assumptions and additional empirical results suggest that these social processes can be intensified by human-like attributes (e.g. speech) [8, 9]. In fact, various studies indicate that social reactions are particularly strong in the presence of a human-like agent. It has for instance been shown that a face attracts attention [10] and automatically leads to attributions of emotion and intention [11] – even to such an extent that the original task is neglected. Further studies indicate that systems including an embodied interface agent are perceived as more credible and bring about increased feelings of trust [12, 13]. Similarly, it has been shown that virtual faces evoke cooperative behavior [4].

Additionally, there is evidence that even subtle social phenomena such as *impression management* [see e.g. 14] are prevalent in human computer interaction. When a human-like face is present, participants aim at leaving a favourable impression by e.g. choosing a socially desirable TV program (documentary about Albert Einstein compared to James Bond movie) [15] or by presenting themselves in a socially desirable way [13].

Merely a few studies have targeted communication processes. Here, agents have proven to affect the communication of the human user: Children accommodate their speech structure to that of the animated character they are conversing with [16] and logfiles of dialogues with a virtual bartender show that when people engage in small talk with the virtual character they take its social role into account [17].

Summing up it can be stated that concerning social effects some aspects have been investigated rather extensively. However, the communication process between user and computer or agent has so far been largely neglected. There are studies on the effects of natural language interfaces pointing to the fact that the language used with a computer differs from the language used between humans [18]. But analogous studies comparing effects of anthropomorphic agents, natural language output and text-based interfaces have not been presented. Specifically, attention should be devoted to whether agents actually do induce more natural interactions. The study presented here tries to answer this question by comparing the reactions and input behaviors of users when interacting with interface agents compared to when interacting with conventional and less anthropomorphic interfaces. Additionally, the study wants to make a contribution to a basic research area by increasing knowledge about the kind and quality of social reactions embodied interface agents evoke.

2 Method

In the study presented here we wanted to test if users react and behave differently when confronted with different interfaces. We were particularly interested in whether users employ more and particular forms of natural speech when faced by a human-like figure. The system used in this experimental study was developed by a joint interdisciplinary research group in the project EMBASSI (Multimodal Assistance for Infotainment and Service Infrastructures, see www.embassi.de) that was funded by the German Ministry of Education and Research (BMB+F). The combined TV-VCR-system assists in choosing a programme as well as in initializing the automated recording. It can be operated either by commands based on natural speech or by a remote control directing a cursor on the graphical user interface (GUI). Subjects were instructed to choose a programme from a list of today´s and tomorrow´s programmes that were displayed on the screen. The recording could be initiated either by remote control (in equivalence to a graphical user interface a button had to be pressed via cursor) or by natural speech (e.g. by saying "James Bond", which was one of the programmes). 65 subjects each had to carry out three tasks: in task 1 and 3 participants were asked to choose from today´s and tomorrow´s programme offer and initialize the recording, whereas in task 2 they were asked to arrange for the recording of a specified programme (a talk-show). During all tasks subjects were free to use natural speech commands or remote control and even were allowed to change the input device within a task (see dependent variables).

The study was conducted at Sony in Stuttgart-Wangen. The experimenter explained how to operate the system and the GUI navigation. Also, in order to increase recognition rates, usage of speech input was practised using two examples. Additionally, subjects were encouraged to try again if recognition failed during the experiment. Due to the system being a research prototype recognition actually failed in several cases, but subjects then patiently repeated their action.

2.1 Independent Variables

Output modalities, i.e. appearance of the interface, were varied. Three different interfaces were presented: GUI only (feedback was given by text on the screen stating e.g. "recording was arranged successfully"), GUI combined with natural speech output (via speech synthesis information about system state was given) or GUI including an embodied interface agent presenting the information via lipsynchronized speech (see figure 1).

Subjects were devided in four groups: Group 1 was asked to carry out the first two tasks with the help of the GUI only condition. Group 2 was confronted with the speech output condition, and group 3 received the embodied interface condition. In order to additionally gather data about which interface was preferred, group 4 was instructed to freely choose any kind of interface for each of the three tasks. Also, people in condition 1 to 3 were told to choose any output modality for the third task. Since interactions with the embodied interface agent were preferred [see 11], this resulted in 91 of the altogether 195 interactions/tasks between human and system being carried out with the embodied interface agent, 49 interactions with speech output and 55 interactions within the GUI only condition.

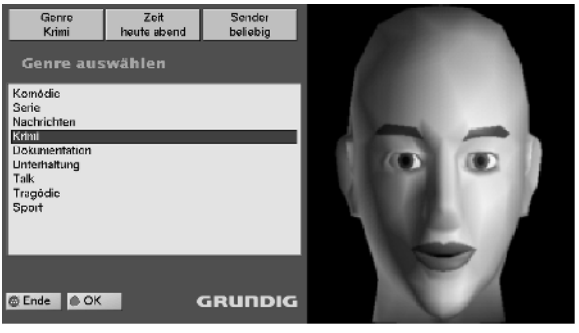

Fig. 1. GUI (by Grundig) including embodied interface agent (by Computer Graphics Centre ZGDV, Darmstadt)

2.2 Dependent Variables

Numerous different variables, such as speed of task solving, steps taken, and liking of the interface were assessed and results were reported elsewhere [19]. Results show that the embodied interface agent is evaluated rather positive, but ratings do not differ from those for speech and text condition. Performance in terms of speed of task solving and number of steps taken also did not prove to be significantly different when comparing conditions. Here, two other dependent variables will be analyzed and presented: a) Behavior of the subjects with regard to the selection of either natural speech commands or using remote control, b) the quality of the users´ utterances. Based on guidelines for qualitative psychological analyses [20], a category scheme was developed to classify the statements according to specific aspects. Since our research question was especially focused on structures and contents pointing to the personalisation and social aspects inherent in the commands, we were not able to use existing schemes or deduce one from theory. Instead, the categories were developed data-driven using one third of the material. All statements were coded using the scheme and occurrence was quantified. Additionally, the frequency of specific words used in social contexts (like “thank you”, “you”) was assessed.

2.3 Participants

In terms of profession, education, and technical/computer experience the sample was quite heterogenous. 29 male and 36 female participants were distributed equally to the conditions. Average age was 39,29 (sd = 15,50, minimum 12, maximum 72).

3 Results

3.1 Input Behavior of Users

Input behavior can be regarded as dependent on output modality (see figure 2): The more human-like features were presented, the more natural speech input the participants used. These differences can also be confirmed in statistical analyses (Anova). Especially in task 2 the differences are significant ($F = 5{,}09$; $df = 62$; $p = {,}009$). A

post-hoc test (Scheffé) shows that during the interaction with the embodied interface agent significantly more speech inputs are made than in the GUI condition (se = ,95; p = ,014). Results are even more distinct for the averaged values of all tasks: Generally, the embodied interface agent evokes more speech input than does the graphical user interface (F = 7,24; df = 191; p = ,001; post-hoc-Scheffé: se = ,73; p = ,001). Differences between GUI and speech output condition did not reach significance. When interacting with the GUI, participants make an average of 1,98 speech inputs per interaction, when listening to speech output they bring forward 3,33 utterances and when confronted with an embodied interface agent, they produce 4,73 speech acts. Results cannot simply be attributed to the fact that interactions with the embodied interface agent took longer since this was not the case [19].

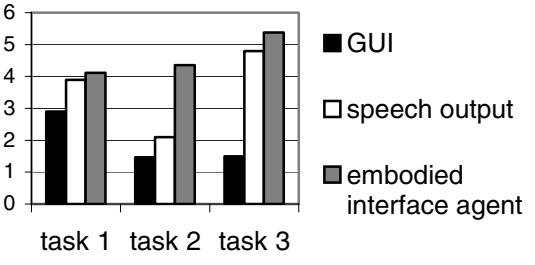

Fig. 2. Average number of speech inputs for three conditions in three tasks

3.2 Semantic Analyses of the Utterances

Based on the result that embodied interface agents triggered more speech input behavior we analysed *what* the participants said exactly. Would the embodied interface condition and other conditions also differ with regard to the semantics of the utterances? To investigate this we at first assessed the frequency of certain words that usually are only used in social contexts, i.e., with a human addressee. Furthermore, we developed a category system that allowed the categorisation of utterances according to specific qualities.

Frequency of Specific Words. For the quantitative analysis of specific words we chose pronouns and specific words such as "thank you" that usually indicate some sort of social relationship. Chosen were *thank you/thanks*, *please*, *you*, *we* and *I*. As can be seen in table 1, the majority of these words were used more frequently when confronted with the embodied interface agents – not only when considering the absolute number, but also when related to the number of interactions and number of utterances which both have been higher in the embodied interface condition (the related value has been calculated in equivalence to a percentage value). In nearly all cases the words are more frequently uttered when confronted with the human-like figure (see table 1). There is a consistent pattern that these words a) are never or rarely used when the interface is text-based, b) appear more often when the interface addresses

the user by speech, but c) are most frequent when confronted with the anthropomorphic interface agent. This pattern is especially distinct with "thanks/thank you", while it does not apply to "I". On the whole it is obvious that the system is more directly addressed and treated more "politely" when represented by a human-like face whereas nearly no such social behaviors are induced by a text-based interface. This hints to the anthropomorphic system being perceived as a social entity.

Table 1. Absolute and relative quantity of specific words indicating a social relationship

		GUI	Speech output	ECA
	Number of interactions	55	49	91
	Number of utterances	168	220	555
Thanks/ Thank you	N	0	1	7
	Related to interactions	0	2.04	7.69
	Related to utterances	0	0.46	1.26
please	N	37	54	159
	Related to interactions	67.27	110.2	174.76
	Related to utterances	22	24.55	28.65
you	N	0	2	6
	Related to interactions	0	4.08	6.59
	Related to utterances	0	0.91	1.08
we	N	0	1	5
	Related to interactions	0	2.04	5.49
	Related to utterances	0	0.46	0.9
I	N	11	14	29
	Related to interactions	20	28.57	31.87
	Related to utterances	6.55	6.36	5.23

Quality of Utterances. Based on the transcribed utterances an extensive category system was developed that enabled a qualitative and - later on - quantitative analysis of the material. One third of the material was used to develop a coding scheme [20]. Then all utterances were coded by two raters who were unaware of the conditions. In order to achieve a high interrater-reliability, the raters jointly coded a part of the material and discussed difficult choices. When specific utterances applied to more than one category, two or more codes were given. The category system is presented in the following.

Instruction to initialize a recording

- Personalized addressation ("record James Bond")
- Unpersonalized addressation ("James Bond, to be recorded")
- phrased as request ("I would like to…")

Requests (e.g. to show a genre or station)

- Personalized ("show me.." "could you show..")
- Unpersonalized ("Channel xy")
- phrased as request ("I would like to…")
- utterances to activate the system ("hello", "just do it")

Questions

- Information seeking ("what is being shown on channel xy?")
- Clarifying questions; interrogative reaction to an action/utterance of the system

Repetition when system does not react or understand

- Exact repetition
- Repetition with slight change

Reactions/utterances that indicate the user´s assumption of a human-like interactive relation

- Explaining comment, when system indicates to not understand ("I just thanked you")
- Correcting utterances ("I did not want that")
- Resignation; user indicates disappointment and surrender
- Comforting of the system after error message ("it´s ok", "don´t cry")
- Request to wait when input is demanded ("just a moment", "wait")
- Other special remarks ("I didn´t either" when system indicates that it did not understand)

Evaluating utterances addressed to the system

- Positive evaluations/utterances; praising of the system (e.g. "great")
- Negative evaluations/utterances (e.g. "terrible")
- Obviously ironic evaluating utterances (e.g. "just wonderful")

Evaluating utterances about the system

- Negative remarks ("this system is annoying")
- Neutral utterances about the system (e.g. about the functioning)

Politeness phrases

- Greetings and Goodbye ("Good evening", "Bye")
- Phrasing implying politeness ("Could you kindly…", "I would like to..")

Other

- Addressing the system with a name ("little one")
- Back channeling ("o.k.", "mmh, yes")
- Thinking aloud/talking to oneself (e.g. "Oh, I first have to press the button")

For every interaction it was coded if at least one utterance of the specific category was present or not. We chose the Chi^2-Test as an appropriate method to analyze differences between conditions. The test was conducted for each category to test for differences between interfaces. For three of the categories significant differences were found. In the following tables the frequencies merely for those three categories with significant differences are presented.

There was a difference for requests that were formulated in a personalized way (see table 2). When users were confronted with an embodied interface agent the number of personalized requests was greater than expected ($Chi = 7.44$; $df = 2$; $p = .024$). While in 12 interactions with embodied interface agents participants use personalized requests, in GUI and speech condition personalized requests are uttered merely once.

These results point to the possibility that users tend to perceive the embodied interface agent as a social entity that is more appropriately addressed in a personalized way.

Additional differences between conditions could be observed with regard to the categories "exact repetition of instruction/request" and "slightly changed repetition of instruction/request".

Table 2. Actual and expected values for the category "personalized request" (Chi=7.44; p=.024)

		GUI	Speech	ECA	total
No personalized request	N	33	41	67	141
	N (exp.)	30.9	38.2	71.9	141
Personalized request	N	1	1	12	14
	N (exp.)	3.1	3.8	7.1	14
total	N	34	42	79	155
	N (exp.)	34	42	79	155

N = actual number; N (exp.) = expected number

Table 3. Actual and expected values for the category "exact repetition" (Chi = 7.6; p = .022)

		GUI	Speech	ECA	Total
No exact repetition	N	24	27	36	87
	N (exp.)	19.1	23.6	44.3	87
Exact repetition	N	10	15	45	68
	N (exp.)	14.9	18.4	34.7	68
total	N	34	42	79	155
	N (exp.)	34	42	79	155

N = actual number; N (exp.) = expected number

As shown in table 3 an exact repetition of the request or instruction is more likely when the system is represented by an anthropomorphic agent (Chi = 7.6; df = 2; p = .022). Also, slightly changed repetitions are more frequent in this condition (Chi = 6.34; df = 2; p = .042; see table 4).

Table 4. Actual and expected values for the category "slightly changed repetition" (Chi = 6.34; p = .042)

		GUI	Speech	ECA	total
No slighltly changed rep.	N	21	27	34	82
	N (exp.)	18.0	22.2	41.8	82
Slightly changed repetition	N	13	15	45	73
	N (exp.)	16.0	19.8	37.2	73
Total	N	34	42	79	155
	N (exp.)	34	42	79	155

N = actual number; N (exp.) = expected number

The latter results may point to the fact that participants in the embodied interface condition felt that they were required to engage in further communication. This might have been due to the demand characteristics of a face "asking" for further interaction. Additionally, this effect could have been intensified by the fact that the face did not show an immediate reaction. The users were therefore probably unsure whether the system had really understood the request.

There were no significant differences for the remaining categories, partly because of the small sample. Nevertheless, a number of specific utterances that were only observable when participants were confronted with the anthropomorphic agent were

quite remarkable. E.g., in the condition of the embodied interface agent three utterances of resignation occurred. Such a behavior was neither observed in the speech output condition nor in the text condition. The pattern is similar regarding correcting comments ("I did not want it this way") that are uttered in five interactions with the embodied interface agent. They occur once in the speech output condition but not at all in the text condition. This also indicates that participants had the impression that a system that was represented by a face would be more responsive to the utterance of interactive, reciprocal commands than the 'non-social', conventional conditions. Results even suggest that the human-like face triggers forms of social behavior that would only be regarded appropriate when interacting with a human being, not with a machine: For instance, some participants in the embodied interface agent condition personally greeted the interface. They ended the interaction with a 'goodbye', personally addressed system with a name ("little one"), or even comforted the agent when it reported the failing of an action. Additionally, utterances can be found that hint to unusual attributions for failed actions: One participant stated "You do not like me, do you?" when the system repeatedly reported a failure.

Summing up it can be stated that qualitative and quantitative analyses consistently show that embodied interface agents induce a significant change in how people interact with technological systems – compared not only to text but also to speech based interfaces. With regard to some aspects the communication even becomes rather human-like, e.g. regarding politeness phrases or expressing empathic sympathy.

4 Discussion

Results confirm that one of the expected profits [2] of embodied interface agents is actually observable: When confronted with a human-like character participants felt free to address it by natural speech. While it may have been awkward to address a merely text based interface it was obviously less a problem when a human face was visible. Thus, the advantage of anthropomorphic interfaces in terms of triggering users´ natural speech input is clearly observable. Even guidelines can be derived from this result: If an interface designer wants the user to engage in natural speech to a greater extent he should consider to put up a human-like face.

Also, clearly social reactions were observed: With an agent present the quality of utterances changed. The system was addressed in a more personalized way. In the embodied interface agent condition the frequency of the pronoun "you" as well as the amount of personalized requests was increased. This can be taken as indicating that the system was perceived as a social entity. Further, users engaged more frequently in reciprocal communication attempts such as correcting comments or resignation utterances. This not only indicates that the users have increased expectations about what the system is going to understand but that they even are more tempted to communicate their state.

Concerning the design of interfaces these tendencies might become a practical disadvantage or problem. Triggered by embodied interface agents the employed vocubulary increases and more unexpected phrases are used. Although this might be a future advantage, problems arise for present technologies. As has been proposed [21] realistic human faces lead to expectations that can not yet be met. Here, users are invited to

use complex phrases and vocabulary that cannot be recognized and analyzed. Thus, when inserting an embodied interface agent the designer must at least be prepared for this phenomenon. One chance to overcome potential problems could be to point out the actual capabilities in a tutorial before first usage. But it can be doubted whether this would be sufficient. The experience we made during the study gives evidence against it: Although we pointed out by both instruction and exercising speech input that the system only has limited abilities in recognising speech, still participants especially in the embodied interface agent condition worded their wishes more freely.

Another practical problem arises when during the system´s processing time the face does not show an immediate reaction of understanding or misunderstanding or at least indicates that the user has to wait for further feedback. Our result of people frequently repeating their input when interacting with an agent points to the danger of presenting a face that sometimes does not react immediately. Even for virtual faces Watzlawick´s statement that you cannot not communicate seems to be true. So the designer has to take into account that users will always perceive the system to be communicating once there is a face visible and that it will be confusing when nothing is happening.

Concerning the question whether embodied interface agents evoke social reactions, it can be summed up that significant changes were observable with regard to different behavioral aspects. So participants used more natural speech input, more frequently addressed the system in a personalized way, attempted to engage in reciprocal communication and even informed the system about personal states – when the agent was visible. These findings once again confirm that when interacting with agents users show behavior that merely is appropriate in human face-to-face interaction. But in addition to the previous findings, our results verify that this also applies to the communication process respectively to the input behavior of the user.

Nevertheless, it remains an open questions whether the users´ reactions will endure or if this is a phenomenon merely observable in laboratory studies where participants are confronted with new technologies for just half an hour. When embodied interface agents appear in our living rooms the effects might disappear. A process similar to the early days of television could happen: Some users at first did their hair on a Saturday evening when the newscaster came to their home but after some time they got used to the fact that the face on the screen did not see them. In order to answer the question if the effects will wear off we have to conduct field studies and observe users during a longer period of usage. Thus, in order to make valid predictions about effects and advantages of embodied interface agents we are not only reliant on more studies e.g. about task appropriateness or adaptation to user groups, but also have to plan studies that provide higher external validity e.g. by conducting them in a more natural setting.

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