Are Computers Still Social Actors?

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Abstract
The initial idea behind the study described in this paper was to assess the perceived socialness of anthropomorphic agents in computer human interaction. In a nuclear power plant simulation scenario users were assisted by an anthropomorphic agent completing several tasks. Afterwards the agent was assessed using questionnaires that were presented in three different modalities. One group completed a pen and paper questionnaire, another one used a web-based version of the questionnaire, and the third group was asked the questions directly by the agent. We expected the group assessed directly by the agent to behave more politely and to overall give the best ratings.

While we did not attain the expected results our study revealed first evidence that the "Computers as Social Actors" paradigm might have to be reconsidered. We argue that the prevalence of computers nowadays might have caused computers not to be treated as "standalone social entities" anymore but to be rather perceived as a "window to the Internet" rendering social behavior towards computers obsolete under certain conditions.

Author Keywords
CASA; Evaluation Modalities

ACM Classification Keywords
H.1.2 [User/Machine Systems]: Human factors

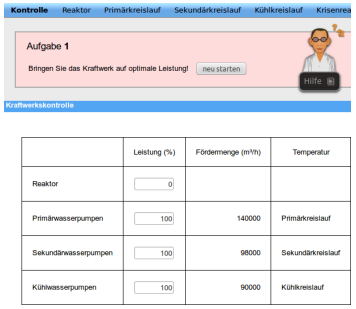

Figure 1: The main page of the interface for the power plant simulation game, with the agent in idle state.

Introduction and Theoretical Background

Users usually neglect that they perceive interaction with computers to be social or similar to interaction with humans [7]. Nevertheless, various studies have shown that the interaction between humans and computers is often influenced by social behavioral patterns. Ground breaking studies in this area were performed by Nass, Steuer and Tauber [8] in 1994. Among other things they were able to show that "users asked by a computer about its own performance will feel compelled to be more positive than will users asked about the computer by an independent source" [8]. Overall, the authors stated that computers should be regarded as social actors and this idea could have been verified by various studies (see [6] for an overview).

Following Langer [5], Nass and Moon attributed this inappropriate social behavior towards computers to be caused by the mindless application of simplistic social scripts learned from human-human interaction to human-computer interaction [7].

In this work, we performed a study to evaluate the influence of using an anthropomorphic agent on the findings of [8]. We were especially interested in the effects on the evaluation of the agent, when the feedback in form of questionnaires was assessed directly by the agent, indirectly but on the same computer by means of a web-based form or indirectly from an independent source, namely a pen and paper questionnaire.

Hypothesis

In Accordance to [8] we stated the following hypothesis: Users in the agent-based group are more polite than users in the web-based group and will give better ratings than users in the online form group. And users in the web-based group are more polite than users in the pen and paper group and will give better ratings than users in the pen and paper group.

Method

Participants

In the experimental study 63 subjects were randomly assigned to one of three treatment groups. 9 participants where excluded from the final analysis due to incomplete data. The average age of participants was 22.59 years ($SD = 2.47$). 52 percent were male and 48 percent female. Male and female subjects have been evenly distributed among groups. Participants were mostly students.

Material

The Simulation Scenario

Subject of interest of this study was the social awareness towards Dr. Nick, a web-based, interactive and anthropomorphic assistant [4].

The setting chosen for the experiment was a nuclear power plant and subjects had to control the power plant for about half an hour. This setting was chosen, as it allows to employ a rather complex model and thus ensures that users heavily rely on assistance.

The simulation game consisted of seven tasks. For example, the user was instructed to reduce the power output of the power plant to a certain value. Solving the tasks involved navigating to relevant pages, entering values into various input fields and clicking buttons.

Features of the Assistant

Dr. Nick offered various possibilities for assistance during task completion. In idle state it was displayed as a small icon along with a button (see Figure 1).

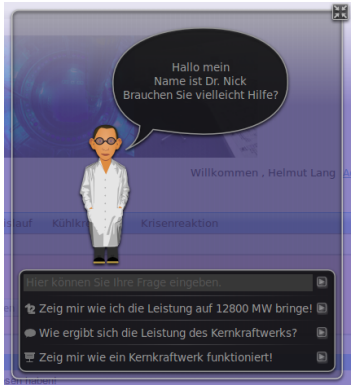

Figure 2: The agent proposing different options for assistance to the user.

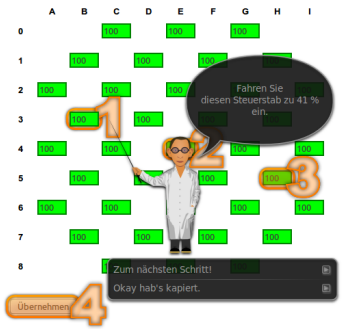

Figure 3: Dr. Nick pointing at an input field and advising the user about the correct value to enter.

When Dr. Nick was activated he offered different options to assist the user with the current task (see Figure 2). The first alternative offered was always the most relevant one. It started a step-by-step instruction that guided the user through all interface elements that needed to be manipulated in order to complete the current task (see Figure 3).

After users had successfully completed one of the step-by-step guides with the help of the assisstant there were three possible ways to close Dr. Nick. The first one was a simple "Thank you!" (positive option) and the second one was a rather depreciative statement telling Dr. Nick not to think too great a deal of himself now (negative option). These two options were displayed as text-buttons below the image of Dr. Nick (similar to the box used for the options in Figure 2). The third possibility of closing down Dr. Nick was a neutral x-button in the upper right corner of the agent's window. Regardless of the option chosen by the subject, the agent just flipped back into idle state, to be displayed as a small icon.

Questionnaires

A questionnaire containing 31 items was developed especially for this study. Each item had to be answered on a 7-point Likert scale ranging from very high disagreement to very high agreement. The items measured the following 6 scales:

help behavior (4 items, Cronbach's α=.79) Assesses the perceived help behavior of the interactive agent. Example: "The agent is helping in a proper way."

impact on user (3 items, Cronbach's α=.48) Measures how comfortable the user felt with the agent. Example: "The presence of the agent appeases me."

optimism (3 items, Cronbach's α=.58) Evaluates if users rank the agent to be an optimist or pessimist. Example: "The agent does not lose his courage, even in case of problems."

tolerance (4 items, Cronbach's α=.66) Assesses how the user feels to be accepted by the agent. Example: "The agent is well-disposed towards me."

humanity (8 items, Cronbach's α=.78) Within this scale high values show that the user attests the agent to be human in some sort of way. Example: "The agent appears lively to me."

competence (9 items, Cronbach's α=.75) This scale was used to find out if the agent is experienced as competent. Example: "The agent seems to be adept and knowing in the area of nuclear physics."

The first two scales ("help behavior" and "impact on user") aimed at assessing the agents actions. The remaining scales were chosen to assess how users rate the agents personality and are loosely based on the German version of the NEO-FFI [1].

In addition to this, we used the AttrakDiff-questionnaire developed by Hassenzahl, Burmester, and Koller [2]. This questionnaire has 28 items belonging to four different scales. Each item consists of bipolar verbal anchors. An example would be "technical" or "human" and the user has to decide on a 7-point scale if he regards the agent to be rather technical or rather human. The four scales of the AttrakDiff-questionnaire are:

perceived pragamtic quality (PQ) This scale measures the potential to support users' need to achieve behavioral goals.

hedonic quality – stimulation (HQS) Through the HQS scale perceived novelty and potential to grab attention is measured.

hedonic quality – identification (HQI) This scale assesses potential of identification with the product,

	agent-based		web-based		pen & paper	
	M	SD	M	SD	M	SD
helpbehavior	5.63	1.00	5.63	1.52	5.48	1.36
impact on user	5.06	0.98	5.04	1.15	5.58	1.09
optimism	4.00	1.32	4.33	1.02	5.13	1.06
tolerance	4.56	1.03	4.92	1.05	5.70	1.04
humanity	2.99	1.29	2.89	0.93	3.28	0.72
competence	5.38	0.72	5.19	0.97	5.44	1.17

Table 1: Means and standard deviations of self-developed scales for all three experimental groups.

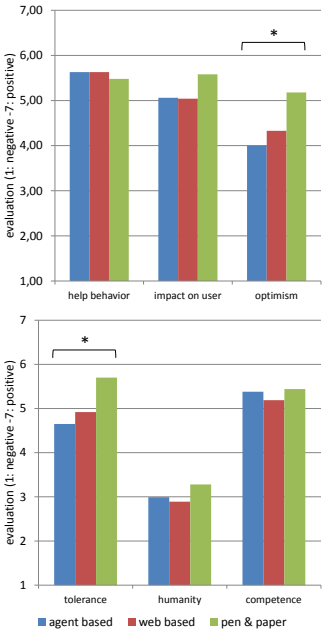

Figure 4: Means for evaluation scales. * $p_1<.05$

which means in our study identification with the agent.

perceived attractiveness (ATT) This scale assesses potential of attractiveness.

The questionnaires for evaluation were presented in three different modalities:

agent group (n=21) The questions evaluating the agent were asked by Dr. Nick directly and were formulated in first person. Example: "How did you you like my performance?"

web-based group (n=18) Subjects within this experimental group were confronted with a web-based form. Questions were formulated in third person.

pen and paper group (n=15) In this treatment group subjects completed a paper-based questionnaire.

Results

Self-developed Questionnaire

Means and standard deviations for the results of our self-developed questionnaire are summarized in Table 1 and also illustrated in Figure 4.

There was no significant difference between our three experimental groups for help behavior ($F<1$, n.s.) and impact on user ($F(2,51)=1.31$, n.s.). An analysis of contrasts also showed no differences.

The scale on optimism revealed a significant difference between the groups ($F(1,51)=4.43$, $p<.05$,$\eta^2=0.15$): Dr. Nick was evaluated to be more optimistic in the pen and paper condition than in the web and agent-based groups ($MD=2.02$, $SE=0.72$, $p<.05$).

The same significant effect could be found for the scale on tolerance ($F(1,51)=3.33$, $p<.05$, $\eta^2=0.12$): Dr. Nick was estimated more tolerant by the pen and paper group than by the two other groups ($MD=1.63$, $SE=0.63$, $p<.05$).

Ratings for humanity and competence of Dr. Nick showed no significant group differences ($F<1$, n.s.). An analysis of contrasts revealed no differences.

AttrakDiff Questionnaire

Means and standard deviations of the results for the AttrakDiff questionnaire are summarized in Table 2.

For pragmatic quality we could show that the agent's support of target achievement differed significantly between the three groups ($F(2,51)=4.24$, $p<.05$, $\eta^2=0.14$): This difference occurs due to the fact, that the pen and paper condition rated Dr. Nick to have significantly less pragmatic quality than the two other conditions ($MD=1.45$, $SE=0.50$, $p<.05$).

Assessment of novelty and potential to grab attention (hedonic quality - stimulation) showed no differences between the three groups ($F(2,51)=1.55$, n.s.).

Regarding assessment of potential of identification (hedonic quality - identification) a significant difference between the conditions could be found ($F(2,51)=7.76$, $p<.05$, $\eta^2=0.23$): Identification was higher in the pen and paper group than in the two other groups ($MD=2.53$, $SE=0.64$, $p<.05$).

The attractiveness scale showed again no significant differences between the three conditions ($F(2,51)=2.46$, n.s.). Also no informative contrasts could be found.

Close option

Of the three options for closing the agent after successfully completing a step-by-step guide users have chosen the positive one in 92.5 percent of cases, the

	agent-based		web-based		pen & paper	
	M	SD	M	SD	M	SD
perceived pragmatic quality (PQ)	4.82	0.71	4.90	0.70	4.13	1.06
hedonic quality - stimulation (HQS)	3.58	0.95	3.51	0.98	4.81	1.27
hedonic quality - identification (HQI)	4.32	0.90	4.44	0.83	4.88	1.17
perceived attractiveness (AT)	4.10	0.91	4.41	0.78	4.82	1.22

Table 2: Means and standard deviations of AttrakDiff-scales for both experimental groups.

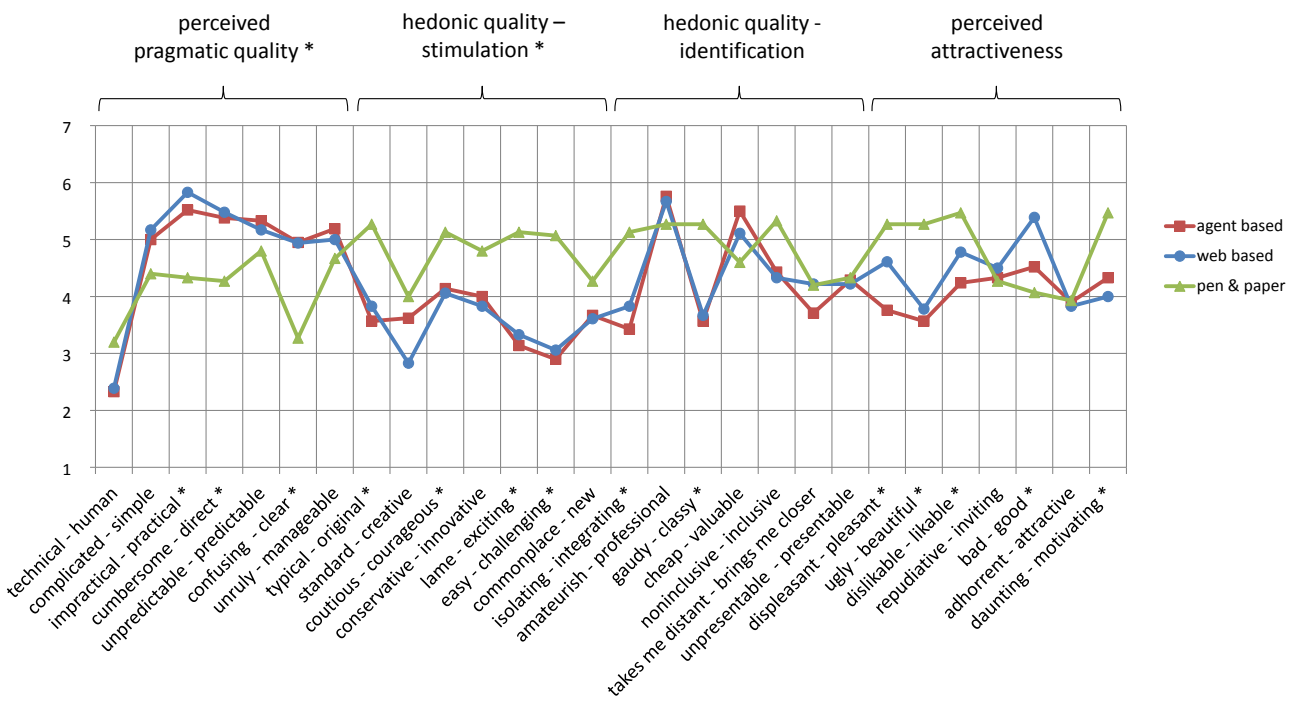

Figure 5: Means of all AttrakDiff items. * $p_1 < .05$

negative one in 5.6 percent and the neutral one in 1.9 percent of cases.

Discussion

The strong preference of choosing the positive option to close the agent after successfully finishing a step-by-step guide perfectly fits the idea of users mindlessly applying social scripts to the interaction with computers [7]. This seems to make the fact that we did not find the expected differences for the different modalities of questionnaires even more peculiar.

Overall we found differences for four out of ten scales and contrast analysis showed that these differences were due to a difference between the pen and paper and the two online (agent- and web-based) conditions. This allows to state that the modality of a questionnaire has an effect on the results attained. Nevertheless the results for the two online conditions were rather congruent. The finding that three out of the scales with differences show better results for the pen and paper based questionnaire clearly contradicts our hypothesis and is thus not conforming to the findings of Nass, Steuer and Taubner [8].

What are possible explanations for this contradictory findings? Within the recent years, users' attitude towards computers might have changed. While computers might have been perceived as a monolithic entity in the past, computers nowadays are usually connected to the Internet. More and more applications are running in a user's web-browser, as was the application used for this study. This implies that applications are no longer restricted to a single computer and a user's data and applications are available on various computers or even smart-phones. Thus the border between "my computer" and the Internet is blurring. Computers might be perceived by users as a window to the Internet. And if there is no well defined physical partner, applying social rules might become less appropriate.

Additionally, in a study performed by Joinson [3] users reported lower social anxiety and social desirability when they were using the Internet compared to paper-based methods.

Hence the mindlessly applied social script towards computers as postulated by Nass and Moon [7] could in the case of the given study have been replaced by the social behavioral script users exhibit in an Internet context.

Conclusion and Future work

This paper presented first indicators that the paradigm of users treating computers as social actors might become obsolete in an increasingly network-based and dislocated computing environment.

To verify this hypothesis and to remove the influence of the anthropomorphic agent that was used for this study, we are planning to repeat the study without the agent.

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