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The influence of direct human-robot interaction on the persuasive power of a robot's facial expressions

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The Influence of Direct Human-Robot Interaction on the Persuasive Power of a Robot's Facial Expressions

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Abstract

Earlier research has suggested that social cues (e.g., speech or facial expressions) could make an social agent's (e.g. artificial social robot's) feedback (e.g. energy consumption) more persuasive, but adding extra social cues provided no evidence of making the social agent more persuasive. The current research investigated whether the addition of facial expressions to a talking social agent made this social agent more persuasive. Because it was not clear in earlier research whether participants perceived all social cues of the social agent, the current research manipulated the interaction between the participant and social agent. By letting the participants talk directly with the social agent, they might also looked at the robot so they perceived all social cues when the social agent gave feedback. The participants performed different tasks in which energy use was the central subject and received feedback on their energy use. Results provided no evidence that participants who interacted directly experienced greater persuasion than those who interacted indirectly. Similarly, results provided no evidence that participants who received the spoken feedback with the additional facial expressions were more influenced by the social agent than those who received spoken feedback only from the social agent. After answering the main questions for this study, an explorative analysis followed.

The Influence of Direct Human-Robot Interaction on the Persuasive Power of a Robot's Facial Expressions

Picture yourself in the year 2030. You wake up as your window tint automatically adjusts to a lighter shade to welcome the sunlight into your room. You head towards your closet and tell your wardrobe robot what you want to wear. Then the robot, without facial expressions, gives feedback on your decision. You then accept or request for another suggestion until you are satisfied. Now imagine your wardrobe robot; would your choice of selection be influenced more if the robot had used facial expressions to support the feedback?

At a more practical level, one area where robots might be useful is in energy saving. Energy conservation has become an important societal issue these days (European Commission, 2000) and there have been past efforts by researchers to encourage consumers to save energy (Abrahamse, Steg, Vlek & Rothengatter, 2005). The use of energy efficient technology can be a good start for people to save energy. For example, the use of extra isolation can help to save energy. However, when the occupant leaves the windows open for ventilation, there is no lower resultant energy use. This example shows that improving the technology is not enough: the user has to change his or her behavior as well (Becker, 1978; Midden & Ham, 2008). There are various methods to influence users. One of those methods is using energy consumption feedback.

Earlier research

Earlier research suggested that appliances with feedback functionalities could result in a lower energy use (e.g., Becker, 1978; Midden & Ham, 2008). Research by McCalley and Midden (2002) suggested that factual feedback could result in energy saving up to 18%. Factual feedback is the energy usage given in numbers (Midden & Ham, 2008).

Feedback is most effective when it has certain characteristics. For example, research suggested that feedback has to be given within a short span of time (Van Houwelingen & Van Raaij,

1989). They suggested that continuous feedback was more effective than a monthly feedback on gas use. However, most energy consuming appliances do not give immediate feedback. In Van Houwelingen & Van Raaij's (1989) research, late feedback was less effective in influencing the consumer's energy usage due to the long time between the behavior (energy use) and feedback (energy bill).

Another characteristic of feedback that has a strong influence to its impact is the social nature (Rosenberg-Kima, Baylor, Plant, & Doerr, 2008). Social feedback is feedback that stems from a social source and the message it contains is an evaluation (Midden & Ham, 2008). Earlier research indicated that adding a body and a face to feedback can make it more "social" (Rosenberg-Kima, et. al., 2008; Vossen, Ham, & Midden, 2009), and doing so results in a lower energy use by the user compared to the same situation using factual feedback (Rosenberg-Kima, et. al., 2008; Vossen, et. al., 2009). A possible explanation for the stronger persuasive effect of social feedback is that the social feedback is more social than factual feedback. Earlier research suggested that people were sensitive to the social evaluation and changed their behavior accordingly (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). An example of social feedback is a person who says, "You are using too much energy."

A very clear example of research in which social feedback from an artificial robot (social agent) is studied, is research by Midden and Ham (2008). In their research, Midden and Ham (2008) used two conditions: a factual feedback condition and a social feedback condition. In the factual feedback condition, the feedback about energy use was given on a control panel of a virtual washing machine. In the social feedback condition, the feedback about energy use was given by an social agent. After the introduction, the participants were asked to do 11 washing trials on a virtual washing machine on the computer screen. Participants received one of the two types of feedback. Both types of feedback were either positive or negative, and had three levels of strength each. That is, factual feedback was given using an energy bar contained in the washing machine interface, that

showed whether a participant's settings lead to energy consumption below or above average, thus indicating positive or negative feedback. Also, the energy bar could indicate consumption either one, two or three levels away from the average level, indicating weak, medium or strong feedback (e.g., strong negative feedback was given by presenting an energy bar that indicated energy consumption three levels above the average). Social feedback was given for each strength of the feedback and contained all a different number of social cues. The weakest feedback was only a facial expression given by the social agent (happy or sad facial expression). The average feedback was a facial expression combined with a light signal from lights on the social agent (red or green). The strongest feedback was a combination of facial expressions, light signals and spoken feedback from the social agent, e. g., "You are doing great!" or "You are using too much energy with these settings." Results showed that social feedback was more effective than factual feedback and resulted in lower energy use by the participant. Midden and Ham (2008) also found that negative feedback was more effective in reducing energy use than positive feedback, and that positive feedback could encourage a higher energy use instead.

However, this previous experiment (Midden & Ham, 2008) contained some confounding variables: feedback type and feedback strength. Strength was combined with type of feedback: a higher level of strength was combined with a higher number of social cues (facial expressions only; facial expressions and light signal; facial expressions, light signal and speech). Because type and strength of feedback were manipulated at the same time, it was not clear what exactly caused the energy saving; was it the additional extra types of feedback or the strength of the feedback? The facial expressions were always added to the strongest level of feedback so it remains unclear if the facial expressions added more persuasive power to the social agent.

In addition to Ham and Midden (2008), a recent study (Vossen, Ham, & Midden, 2010) suggested that one social cue was sufficient to reach the maximum level of persuasiveness of a social agent. According to Vossen, et. al. (2010), the effects of additional cues are not additive and that it is

not necessary to add more social cues to a social agent. That is, their research suggested that adding embodiment to speech led to an increase in persuasiveness as using only speech to give energy conumption feedback.

However, the persuasive effects of using facial expressions were not disentangled from the persuasive effects of using words in Vossen, et. al.'s (2010) research. In their research, "speech" was not only made up of spoken words, but also had facial expression components when the social agent gave feedback. The conclusion of Vossen et. al. (2010) was based on the comparison of the persuasive effects of a speaking computer with the persuasive effects of a social agent (speaking robot with facial expressions). In the end, the specific, independent effects of facial expressions are still not known. The results only allowed us to gain insight of the persuasive effects of the combination of speech with facial expressions.

In contrast to the study of Vossen, et. al. (2010) suggesting that one social cue is sufficient, earlier studies in the literature suggested otherwise. Fogg (2003) suggested that more social cues can enhance persuasive power which means that a social agent with more social cues is more effective in influencing the user to save energy. Social Agency Theory (Mayer, Sobko, & Mautone, 2003) and the Social-Cue Hypothesis (Louwerse, Graesser, Lu, & Mitchell, 2005) also suggest that more social cues in an interaction results in more social interaction and thus enhances the persuasive power. Mayer, et. al. (2003) and Louwerse, et. al. (2005) argue that with more social cues available, people try to understand the relationship with the one (social agent) they are talking with better.

The Current Research

Because the conclusion of Vossen et. al. is in contrast to conclusions that can be drawn based on The Social Agent Theory (Mayer et. al., 2003) and Social-Cue Hypothesis (Louwerse et. al., 2005), the current research was carried out. The current research investigated the effect of adding facial expressions to that talking social agent *in a situation of direct interaction* compared to adding facial expressions to that talking social agent *in a situation of indirect interaction* on the persuasive power

of a social agent. As far as I know, the effect of facial expressions on changing behavior were not investigated earlier. However, earlier research only investigated *recognizing* facial expressions (e.g. Ekman, Rolls, Perrett, & Ellis, 1992), and suggested that people are usually very good at recognizing facial expressions. Earlier research indicated that "*people equate media (computers, cameras and robots) with real life since people respond socially towards media and are completely unaware of it*" (Reeves & Nass, 1996, p. 1). For example, people are sensitive to critisicm and compliments by computers (Reeves & Nass, 1996). In addition to Reeves and Nass (1996), another study suggests that humans communicate with robots the same way humans do with each other (Bracken, Jeffres, & Neuendorf, 2004).The theory that people respond to robots the same way they respond to other people (Reeves & Nass, 1996) suggests that scientific knowledge about human-human interaction can be applied on human-robot interaction. Earlier research suggested that people use facial expressions in human-human interacton to show emotions (Etcoff & Magee, 1992). Earlier research also suggested that people use emotions to persuade other people (Dillard & Pfau, 2002; Petty, Fabriga, & Wegener, 2003). Combining those two, I argue that people use facial expressions to convey their emotions to other people, and thereby use facial expressions to persuade other people. Therefore, I expect that in human-robot interaction, using facial expressions will enhance the persuasiveness of the robot compared to feedback given by a social agent that does not use facial expressions.

I expected that in the current research the social agent that uses facial expressions to enhance the persuasive power of its spoken utterances would be more effective than the talking social agent that does not use facial expressions. This was in contrast with the discussed study (Vossen, et. al., 2010), where adding more social cues had no significant effect. The results of Vossen, et. al. (2010) suggested that not all social cues help in enhancing the persuasiveness of a social agent. Importantly, another possible explanation for Vossen et. al.'s comclusion was that the participants did not *see* the facial expressions of the social agent, because the virtual washing machine was on the computer screen and the social agent (the physical robot) was located next to the screen. The

participants were perhaps only looking at the screen where all options of the virtual washing machine were presented. When the participants really did not see the facial expressions in Vossen et. al.'s (2010) study, the results would not be in contrast with the The Social Agent Theory (Mayer et. al., 2003) and Social-Cue Hypothesis (Louwerse et. al., 2005). Therefore, the current research manipulated what we labelled 'directness' of the interaction. Direct interaction means that the participant also has to talk to the social agent instead of only listening. While talking to the social agent, there is a higher chance that participants will see the facial expressions of this social agent compared with situations where participants only have to listen to the social agent.

The current research consisted of two parts: the Pretest and the main experiment. The Pretest tested if participants evaluated the happy facial expressions different form the sad facial expressions. I had the following hypotheses:

H1: Participants evaluate the happy facial expressions different from the sad facial expressions

H2: Participants evaluate all happy facial expressions different from each other and the differences are in the right order (the three facial expressions are evaluated in the right order by the participants).

H3: Participants evaluate all sad facial expressions different from each other and the differences are in the right order (the three facial expressions are evaluated in the right order by the participants).

The experiment investigated the combined effect of the directness of an interaction between a social agent and the participant and the effect of adding facial expressions to the talking social agent on the persuasiveness of this social agent. I had the following hypotheses:

H1: Participants who interact directly with the social agent will be persuaded more than participants who interact indirectly with the social agent.

H2: Participants who receive feedback containing speech and facial expressions from the social agent will be persuaded more than participants who receive feedback containing only speech from the social agent.

H3: Participants who interact directly with the social agent will be persuaded more when the social agent uses both speech and facial expressions than participants who interact directly with a social agent that uses speech only. For participants who interact indirectly with the social agent, I expect that adding facial expressions to the talking social agent is less effective in persuading.

Pretest

The pretest of the current research used most of the methodology developed in previous studies (Midden & Ham, 2008; Vossen, et. al., 2010) that used an iCat robot that was able to show different facial expressions. The Pretest used three positive facial expressions (happy) and four negative facial expressions (sad) of different degrees. The Pretest measured significant differences between those facial expressions by showing the participant movies of the facial expressions. This was to ensure that the facial expressions were matching with the spoken words used in the main experiment.

Method

Participants and Design

Seventeen students from Eindhoven University of Technology (9 males and 8 females) participated in the experiment. The age of the participants was between 19 and 38 years *(M = 25.94, SD = 4.40)*. It took 15 minutes to finish the questions and the participants received 5 euro's for participating.

Materials

The movies shown in the Pretest were animations that represented the iCat robot (social agent) of earlier studies (Midden & Ham, 2008; Vossen, et. al., 2010). The animations were able to express facial expressions. The facial expressions I used in the Pretest were three positive and four negative ones from Vossen, et. al. (2010). I designed the fourth sad facial expression by myself, because the strongest sad facial expression was not strong enough in my opinion. The questions asked about the social agent's emotion were adapted from the PANAS (Watson, Clark, & Tellegen, 1988). More specifically, I only used the joviality and hostility scales including all items of these two scales, because only these were representing positive and negative emotions and were closest in the PANAS to the happy and sad facial expressions I used. Thereby, all seven facial expressions were rated on the two separate factors: the hostility factor and the joviality factor. Finally, a reliable measure for joviality ($\alpha = .94$) and hostility ($\alpha = .94$) was calculated based on a participants scores on all items for each of the two factors. I also used a factor analysis to check that the data used in the pretest also contained the same factors as the Watson et. al. suggested in the PANAS scale. According to the factor analysis, all items were matching with the suggested ones in the PANAS.

Procedure

Participants were invited to participate in an online questionnaire about emotions of robots. When opening the questionnaire in their web browser, the participant had to read a small introduction about the study. The introduction explained that the participant was going to make judgments about a robot's feelings. The next page of the online questionnaire contained a movie of a robot that was expressing a specific facial expression. Next to this movie was a list of thirteen statements (e.g., "the robot is happy") and the participant had to rate on a five-point Likert scale to what extend he or she agreed with each statement. These thirteen statements were the joviality and hostility items from the PANAS (Watson et. al., 1988). Six more pages followed. Every page had the same 13 statements and a different movie of a facial expression. After the seven pages with different

facial expressions, the participant's age and gender were asked. Finally, the participants were thanked for participating.

Results

To analyze whether participant's evaluations of the happy and sad facial expressions were different from each other, I submitted the average of all participant's evaluations of the four sad iCat faces, and the average of all evaluations of all the three happy iCat faces to a t-test.

The analysis indicated that participants evaluated the happy facial expression *(M = 3.06, SD = .66)* higher than the sad facial expressions *(M = 1.24, SD = .30)*, *F(1, 16) = 150.28, p < .05)* on the joviality scale. The analysis indicated that participants evaluated the sad facial expressions *(M = 2.10, SD = .52)* lower than the sad facial expressions *(M = 1.33, SD = .52), F(1, 16) = 32.63, p < .05)* on the hostility scale.

To analyze whether participant's evaluations of the different faces were different from one another, I submitted each participant's evaluations of the four sad iCat faces, and the three happy iCat faces to two separate repeated measures GLMs. The two GLM's were for the happy and sad facial expressions.

This analysis indicated that overall the participants evaluated the happy facial expressions differed from another *F(1,31) = 60.01, p <.05)* on the joviality scale. The analysis showed that the participants evaluated all happy facial expressions differ from each other on the joviality scale, but the analysis provided no evidence that the participants evaluated the three strengths of facial expressions differ from each other on the hostility scale (see subscripts in Table 1). Table 1 shows the mean evaluations for each of the happy facial expressions (and standard deviations) and provides an overview of which means differ from which.

Table 1. The Average Hostility evaluation and Average Joviality evaluation of the three happy facial expressions.

Factor	Mean	SD
Hostility (Happy L1)	1.39_a	.65
Hostility (Happy L2)	1.30_a	.56
Hostility (Happy L3)	1.29_a	.58
Joviality (Happy L1)	2.18_a	.80
Joviality (Happy L2)	3.26_b	.94
Joviality (Happy L3)	3.75_c	.81

Note: For hostility evaluations and joviality evaluations separately, averages in columns with different subscripts differ at $p < .05$

The analysis also indicated that overall the participants evaluated the sad facial expressions different from another $F (1, 31) = 53.18, p < .05)$ on the hostility scale. A specific contrast analysis showed that the participants did not evaluate all sad facial expressions differ from each other on the hostility scale, the analysis also provided no evidence that the participants evaluated the four strengths of facial expressions differ from each other on the joviality scale (see subscripts in Table 2 with the results). Table 2 shows the mean evaluations for each of the sad facial expressions (and standard deviations) and provides an overview of which means differ from which.

Table 2. The Average Hostility evaluation and Average Joviality evaluation of the four sad facial expressions.

Factor	Mean	SD
Hostility (Sad L1)	1.39_a	.65
Hostility (Sad L2)	2.25_b	.66
Hostility (Sad L3)	2.38_b	.90
Hostility (Sad L4)	2.37_b	.97
Joviality (Sad L1)	1.18_a	.29
Joviality (Sad L2)	1.26_a	.37
Joviality (Sad L3)	1.25_a	.34
Joviality (Sad L4)	1.25_a	.39

Note: Averages in columns with different subscripts differ with $p < .05$

Discussion

The aim of the Pretest was to investigate whether participants evaluated the facial expressions used in Vossen et. al. (2010) different on the joviality and hostility scale. Therefore, the participants had to evaluate all these facial expressions on the joviality scale and the hostility scale (adopted from the PANAS) in an online questionnaire. The results indicated that participants evaluated the happy facial expressions different from the sad facial expressions, because there was a difference between the average joviality level of the happy facial expressions and the sad facial expressions. There was also a difference between the average hostility level of the sad facial expressions and the happy facial expressions. This finding is in line with my first hypothesis where I argue that participants evaluate the happy facial expressions different from the sad facial expressions.

Furthermore, the current results suggested that participants evaluated all three strengths of the happy facial expressions different from each other on the joviality scale and evaluated the weak happy face to be less jovial than the medium happy face than the most happy face. This is in line with

my second hypothesis where I argue that participants evaluate all happy facial expressions differently.

For the four levels of sad facial expressions, although only the hostility scale of the weakest sad facial expression significantly differed from the next level, the means of the different levels on the scale were towards the expected direction, that is: as the level of the facial expression increases, the higher it is on the hostility scale. The results also provided no evidence that participants evaluated the fourth strength of sad facial expressions different from the third one. I decided to remove the fourth facial expression in the main experiment so the resulting number of happy facial expressions and sad facial expressions were equal again.

Experiment

This experiment used the methodology developed in earlier studies (Midden & Ham, 2008; Vossen, et. al., 2010) that used a virtual washing machine and an iCat robot that was able to show different facial expressions. In this experiment, I used the three happy and three sad facial expressions that were selected at the end of the Pretest. The selected facial expressions were the same as the ones used in the earlier studies. The participants had to do eleven washing trials during this experiment and the iCat robot functioned as a social agent and gave feedback on the participant's energy use.

Method

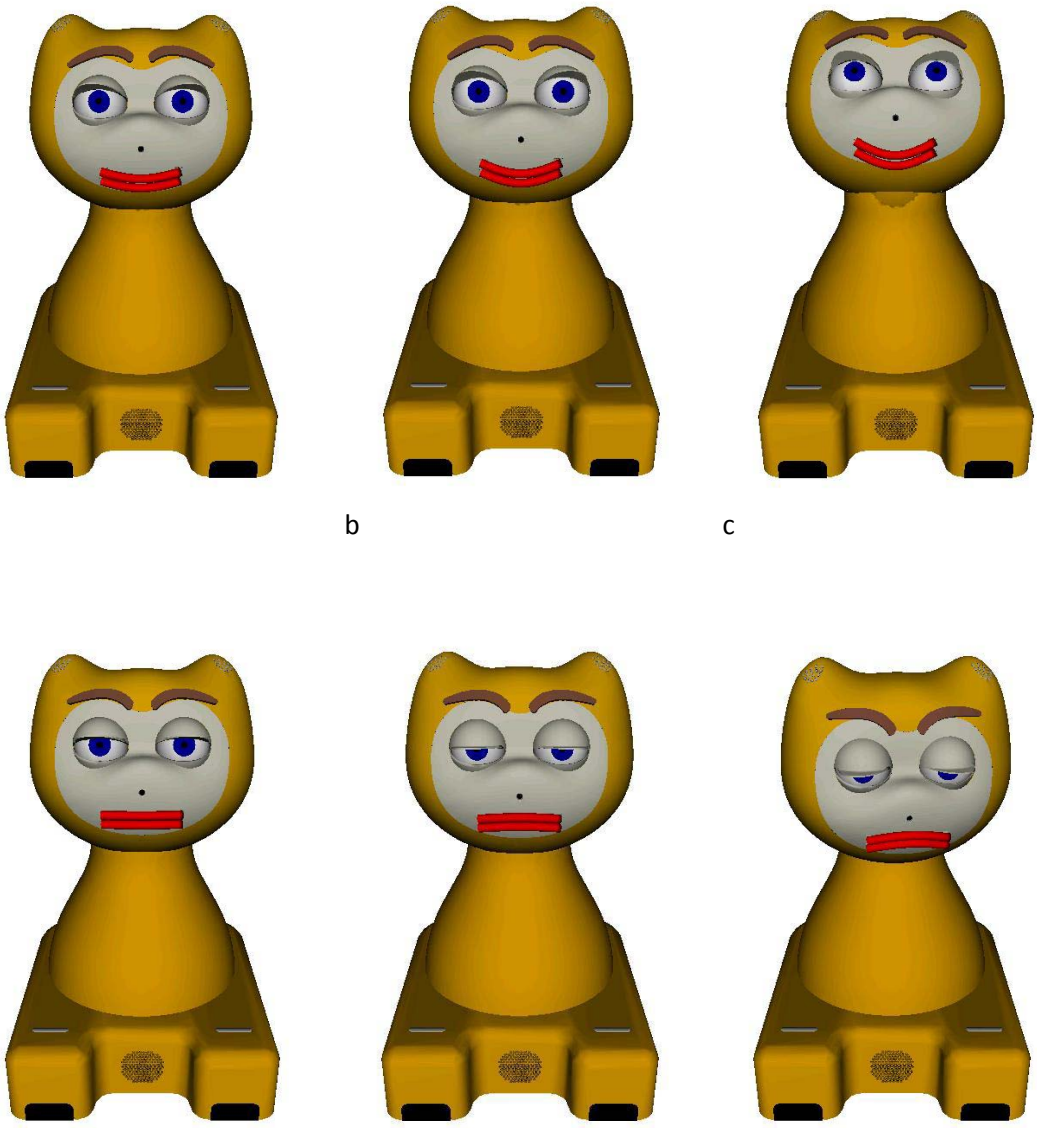
Participants and Design

A 2 (interaction type: direct vs. indirect) x 2 (feedback type: speech vs. speech & facial expressions) x 11 (washing trial one to eleven) model was used, where the first two were between and the last variable was within. During the experiment, 91 students from Eindhoven University of Technology (49 males and 42 females) participated. The age of the participants was between 15 and 59 years *(M = 26.76, SD = 12.47)*. It took 20 minutes to finish the experiment.

Materials

To assess a participant's evaluation of the robot, I used the GODSPEED questionnaire (Bartneck, Kulic, Croft & Zoghbi, 2009). The GODSPEED questionnaire has five scales, each of which is measured using 5 items. For each of these scales, I calculated a reliable measure based on its 5 items: anthropomorphism *(α = .82)*, animacy *(α = .77)*, likeability *(α = .88)*, perceived intelligence *(α = .79)* and perceived safety *(α = .09)*. I also used a factor analysis to check that the current study's data also contained the same factors as Bartneck et al. (2009) suggested. According to the factor analysis, the items from that used to be anthropomorphism and animacy were sometimes overlapping, but in general all the factors were matching. Only the factor that used to be "perceived safety" did not match with the items suggested by Bartneck et al. (2009).

During the main experiment, I used the iCat as a social agent to show three positive and three negative facial expressions (see Figure 1). These facial expressions were combined with the following sentence: "your energy use is" "geweldig" (perfect), "zeer goed" (really good), "goed" (good), "slecht" (bad), "zeer slecht" (really bad) of "verschrikkelijk" (terrible). The iCat, its facial expressions and the spoken feedback were adopted from Vossen et. al. (2010). The facial expressions were tested during the Pretest and I concluded that I could use these facial expressions in the current study.



a b c

d e f

Figure 1: The iCat's facial expressions: good (a), really good (b), perfect (c), bad (d), really bad (e), terrible (f).

The iCat was placed left from the computer screen, shown in Figure 2.

Figure 2: The setup of human-robot interaction in the main experiment.

Participants had to read the instructions on the screen. Besides instructions, there was also a virtual washing machine program running on this computer. The virtual washing machine was also adopted from Vossen et. al. (2010). The virtual washing machine program looked like a control panel of a normal washing machine (Figure 3).

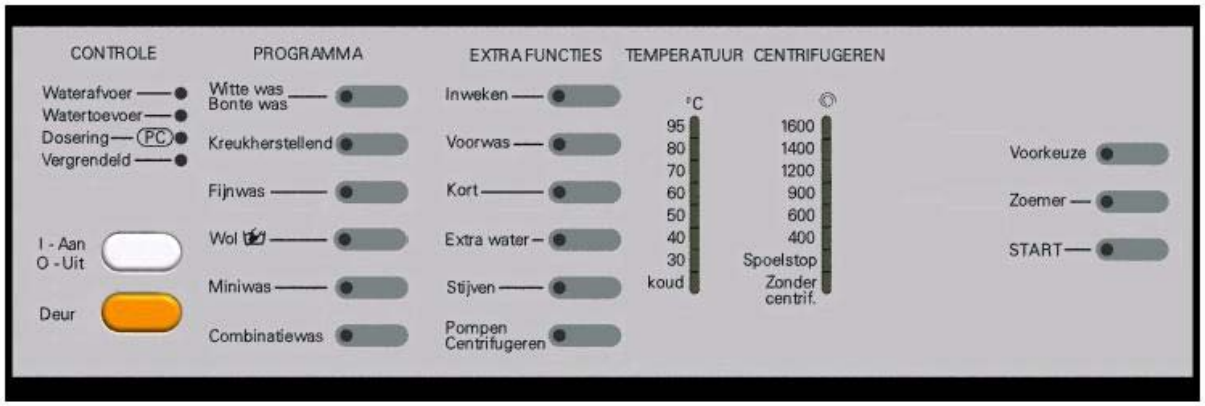


Figure 3. The interface of the virtual washing machine.

When a washing program was selected, the corresponding light turned yellow. This applied also to the extra functions, temperature and cycling speed.

Procedure

Participants were invited to participate in an experiment about saving energy in households while using a virtual washing machine. When participants arrived, they were placed at a table with a computer. Next to this computer an iCat robot was placed. An iCat is a robot with the upper body and the head that looks like a cat's head. This iCat was able to show social expressions by using its lips, eyes and eyebrows. It was also possible to play sound files through the iCat. The iCat was used as a social agent in the main experiment. At the beginning of the experiment, participants were asked to read the instructions on the screen and had to click on the button 'next' each time they finished reading. After the introduction, the participants had to read how to control the virtual washing machine. Participants who were going to interact indirectly with the social agent (iCat) read the instructions about how to control the virtual washing machine with the computer mouse. Participants who were going to interact directly with the social agent got explained by the text on the screen that they had to talk to the social agent to control the washing machine. In both direct and indirect interaction situations, the participants received instructions that they had to set the washing program, extra functions, temperature and spinning speed in this order. Together with the explanation, the participant saw the picture of the washing machine interface (see Figure 3).

After this, a practice trail followed. The practice trail was meant to let the participant to get used to control the washing machine by mouse or by voice. The exercise was written on the screen. After this, the participant had to set the washing program, extra functions, temperature and spinning speed. Participants who interacted indirectly had to click on the washing program they wanted to use. Participants who interacted directly had to tell the social agent what washing program they wanted to use. The social agent selected the washing program on the virtual washing machine for the participant. When the participant selected the washing program, the social agent gave one of the following spoken feedbacks according to the amount of energy use of the selected washing program: "your energy use is" "geweldig" (perfect), "zeer goed" (really good), "goed" (good), "slecht" (bad),

"zeer slecht" (really bad) of "verschrikkelijk" (terrible). In half of the cases, the social agent combined this feedback with one of the six corresponding facial expressions shown in Figure 2.

After setting the washing program, the participant had to set the extra functions, temperature and spinning speed. The social agent gave feedback on every change in energy use. The participant had to start the washing machine by clicking on start in the indirect interaction condition and telling the social agent to start the washing machine in the direct interaction condition. After this, ten more tasks followed. Each task followed the same procedure as the practice trail. Finally, the participant had to enter his age and gender and were thanked for participating.

Results

The energy consumption score was submitted to a 2 (interaction type: direct vs. indirect) x 2 (feedback type: speech vs. speech & facial expressions) x 2 (feedback valence: positive vs. negative) x 3 (feedback strength: weak vs. average vs. strong) MIXED Model.

The first hypothesis proposes that the social agent in the direct interaction situation would be more persuasive than the social agent in the indirect interaction situation. However, in contrast to Hypothesis 1, the results provided no evidence for a difference in energy use between participants who interacted directly with the social agent *(M = -.16, SD = .76)* and participants who interacted indirectly with the social agent *(M = -.13, SD = .45), F(1,115.656) = 1.966, p = .16*.

The second hypothesis proposes that the addition of facial expressions to speech on a social agent would be more persuasive than only speech. In contrast with hypothesis 2, the results provided no evidence that there is a difference in energy use between participants who received only spoken feedback *(M = -.14, SD = .81)* and participants who received facial expressions combined with speech *(M = -.15, SD = .85), F(1,115.656) = .374, p = .54*.

The results were also in contrast to hypothesis 3: participants who interact directly with a social agent will be persuaded more when the social agent uses both speech and facial expressions

than participants who interact directly with a social agent that uses speech only. The results provided no evidence that the *interaction type* x *feedback type* was significant (see Table 3), *F(1,115.656) = 1.910, p = .17*.

Table 3. Average difference in energy use (and SD's) of participants depending on interaction type and feedback type.

	Indirect	Direct
Speech	-.12 (.67)	-.18 (.53)
Speech + Facial Expressions	-.14 (.61)	-.14 (.54)

Note: Averages in rows and columns with different subscripts differ with $p < .05$

Furthermore, exploratory analyses suggested that the interaction of *feedback valence* x *interaction type* x *feedback type* was significant, *F(1,3396.979) = 6.273, p = .01*. For the negative feedback, results suggested differences in energy use between the four conditions of the 2 (interaction type: direct vs. indirect) x 2 (feedback type: speech vs. speech & facial expressions) interaction[1]. For the positive feedback, results suggested no differences in energy use between the four conditions of the same interaction. Only when the participant received negative feedback from the social agent and the social agent only used speech to give feedback, participants were using less energy when interacting directly with this social agent than when interacting indirectly. (see Table 4).

Table 4. Average difference in energy use (and SD's) of participants by feedback valence, interaction type and feedback type.

	Positive Feedback		Negative Feedback	
Interaction Type	Indirect	Direct	Indirect	Direct
Speech	$.03\ (.56)_a$	$.01\ (.52)_a$	$-.27\ (.50)_b$	$-.36\ (.48)_c$
Speech + Facial Expressions	$.04\ (.56)_a$	$.01\ (.52)_a$	$-.31\ (.47)_b$	$-.28\ (.49)_b$

Note: Averages in rows and columns with different subscripts differ with $p < .05$

[1] It is not possible to analyze a simple interaction inside a Mixed Model. Thus when positive and negative were analyzed separately, results suggested that the interaction was significant *F(1,80.456) = 4.770, p = .03* at the negative side and not significant at the positive side *F(1,173.374) = .077, p = .78*.

Participant's scores on each of the GODSPEED dimensions were submitted to a 5 (factor: Anthropomorphism vs. Animacy vs. Likability vs. PerceivedIntelligence vs. PerceivedSafety) x 2 (interaction type: direct vs. indirect) x 2 (feedback type: speech vs. speech & facial expressions) GLM, in which the GODSPEED factor was manipulated within participants.

First, the analysis showed that there were differences between all dimensions of the GODSPEED questionnaire, $F = 54.05, p < .05$. This indicates that participants answered differently on all five dimensions of the GODSPEED, but this is irrelevant for the current research. Second, the analysis provided no evidence that there was any difference on the answering the GODSPEED questionnaire when participants were communicating directly or indirectly with the social agent (interaction of *GODSPEED* x *Interaction Type*), $p = .79$. Third, the analysis also provided no evidence that there was any difference on answering the GODSPEED questionnaire when participants received only feedback from the social agent through speech only or through speech and facial expressions (interaction of *GODSPEED* x *Feedback Type*), $F = 1.15$. Finally, the analysis also provided no evidence for the interaction of *GODSPEED* x *interaction type* x *feedback type*, $p = .56$. This means that the answers of the participants in the GODSPEED questionnaire was the same in all conditions and that the data of the GODSPEED questionnaire could not be used for this analysis.

Discussion

The aim of the Pretest was to check whether the happy and sad facial expressions were being evaluated differently from each other and that the strengths were in the right order. The results of the pretest showed that participants evaluated happy facial expressions differently from the sad facial expressions. The results also suggested that the strengths of the happy and sad facial expressions were in the right order (from weak to strong). The conclusion of the pretest was that the facial expressions used in earlier research (Midden & Ham, 2008; Vossen et. al., 2010) were recognized by the participants the same as they supposed to be. Therefore we used these facial expressions were used in the main experiment of the current study.

The aim of the experiment of the current study was to investigate the addition of the pretested facial expressions to the talking social agent in an indirect interaction situation compared with the addition of facial expressions to a talking social agent in a direct interaction situation. Investigating the persuasive power of a social agent that interacts directly or indirectly with the user, and that uses speech only to provide feedback, or both speech and facial expressions. To investigate this question, participants were asked to perform several washing tasks with a virtual washing machine. The participants were divided in four conditions and got feedback on each action they did. A social agent gave the spoken feedback with or without facial expressions in the direct and indirect conditions.

The results provided no evidence for a difference in energy use between participants who interacted directly and participants who interacted indirectly with the social agent. This means that there is no evidence that the persuasive power of the robot in the indirect communication situation is different from the robot of the direct communication situation. This result is in contrast with my hypothesis where I expected that the social agent would be more persuasive in the direct interactions compared with the indirect interactions with the social agent. The results also provided no evidence for a difference in persuasive power of the social agent that used only speech as feedback and the social agent that used speech combined with facial expressions as feedback. This means that adding facial expressions to a speaking social agent was not resulting in a more persuasive social agent. These results are in line with the research by Vossen et. al. (2010) in which they found that additional social cues did not enhance the persuasiveness of the social agent. The results of the current research suggested that the addition of facial expressions are not enhancing the persuasive power of the social agent or that the difference between direct and indirect interaction in this study was not good enough.

However, when the valence of the feedback was added to the interaction in the main experiment, the analysis showed that in the situations where the participant received negative

feedback from the social agent and the social agent only used speech to give feedback, participants were using less energy when interacting directly with this social agent than when interacting indirectly. This result suggests that when people are able to set the washing machine by talking to the social agent and receiving only spoken feedback, they are using less energy then the people who are setting the washing machine manually. Adding facial expressions to the social agent seems to make the effect weaker. Also, adding facial expressions in a direct interaction resulted in a higher energy use. A possible reason for this might be that the spoken feedback and the facial expressions did not match together. The fact that these results were only found for negative feedback can be explained by the earlier finding that negative feedback is more effective than positive feedback (Baumeister, Bratslavsky, Finkenauer & Vohs, 2001). When participants were interacting indirectly with the social agent and only received negative feedback, results provided no evidence that the social agent was more persuasive with only speech as feedback compared with speech combined with facial expressions. This suggests that the participants maybe did not see the facial expressions of the social agent. This result is also in line with Vossen et. al. (2010), where a social agent with more social cues did not result in a social agent that is more persuasive. However, when participants were interacting directly with the social agent there was a difference in persuasiveness of the social agent between spoken feedback and spoken feedback combined with facial expressions. However, the results suggested that the social agent using only speech was more persuasive than the social agent using speech and facial expressions. This result is in contrast with the Social Agency Theory (Mayer et. al., 2003) and the Social-Cue Hypothesis (Louwerse et. al., 2005) where additional social cues resulted in a social agent with a higher persuasive power compared with a social agent with less social cues. The result that an extra social cue made the social agent less persuasive might be explained because the participants might have felt uncomfortable while talking to the robot. The participants also might had a too high expectancy of the social agent and felt disappointed when they realized that the social agent was only able to say a few sentences. In the literature this is also known as the Uncanny Valley (Mori, 1970). Another possible explanation for the contrasting result

might be the fact that the virtual washing machine was new to the participant. This virtual washing machine was not exacly the same as their washing machines at home. Because of this, the participants may have had to look towards the screen often and could not simply set the washingmachine without looking at it, that means that they did not see all facial expressions.

The results also provided no evidence that the condition of the participant influenced the answers the participants gave in the GODSPEED questionnaire. This suggests that the participants did not evaluated the social agents in the direct interaction more human like then the social agents in the indirect interaction. A possible explanation for this might be that the items of the factors in the GODSPEED questionnaire, taken after the experiment, were not perfect in line with the proposed combinations in Bartneck et. al. Another possible explanation can be that the sample size was too small.

Future research investigating effects of adding facial expressions to speech can try some other way of letting the participants look at the social agent. This might means that the manipulation was not good enough, and that participants were still looking at the screen with the virtual washing machine in the direct interaction conditions. In other words: in the direct interaction situation, there was only a higher chance that the participants saw facial expressions. Also, participants were not forbidden to look towards the social agent in the indirect interaction situation, so they might saw some facial expressions as well. When researchers planning to continue, I suggest using an eye tracker or some other technique to be sure that the participants are looking at the social agent while the social agent gives feedback. I advise future researchers also to pretest the combination of the facial expressions and the spoken feedback, because some results are suggesting that.

Back to the robot in the introduction. Will the talking wardrobe robot, who also listens to you asking for clothes, be more effective in influencing you when he has facial expressions? The current results suggest that this is not the case: That robot will be less effective in influencing you and you might take the short pants and the t-shirt while it is snowing.

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