The Effect of an Intelligent Virtual Agent's Nonverbal Behavior with Regard to Dominance and Cooperativity

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Abstract. In order to design a successful human-agent-interaction, knowledge about the effects of a virtual agent's behavior is important. Therefore, the presented study aims to investigate the effect of different nonverbal behavior on the agent's person perception with a focus on dominance and cooperativity. An online study with 190 participants was conducted to evaluate the effect of different nonverbal behaviors. 23 nonverbal behaviors of four different experimental conditions (*dominant, submissive, cooperative and non-cooperative* behavior) were compared. Results emphasize that, indeed, nonverbal behavior is powerful to affect users' person perception. Data analyses reveal symbolic gestures such as crossing the arms, stemming the hands on the hip or touching one's neck to most effectively influence dominance perception. Regarding perceived cooperativity expressivity has the most pronounced effect.

1 Introduction

With the rise of embodied artificial interaction partners that are potentially able to display nonverbal behavior it is important to understand which behaviors elicit what perceptual or behavioral reaction on the side of the human interlocutor. In particular dominance and cooperativity perception have an important influence on the user and the human-agent-interaction. For some applications persuasive effects are essential (e.g. agent reminds user to take his meds) which might be strongly supported by dominant (nonverbal) behavior [1]. Otherwise, many applications require the interlocutor to cooperate with the virtual agent. To enhance the sense of cooperation between human and agent, the agent has to be perceived as cooperative. Thus, in order to design a successful human-agent-interaction, the influencing factors of an agent's person perception have to be investigated. Since about 60–65 % of the social meaning is evoked by nonverbal behavior [2], especially the impact of nonverbal cues on dominance and cooperativity has to be focused. In order to investigate the effect of nonverbal behavior on person perception, it has to be analyzed what kind of nonverbal behavior evokes a dominant and cooperative person perception. Based on the literature we found a number of nonverbal behaviors that are assumed to evoke dominance or cooperativity. Although

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there is a broad understanding of what exact kind of behavior leads to a dominant or submissive evaluation, systematic investigations of those behaviors are missing. Therefore the results of the presented study enhance the current state of the art with a comparison of various nonverbal behaviors with regard to their dominance and cooperativity perception.

2 Dominant Nonverbal Behavior

In human-human-interaction (HHI) the nonverbal behavior is of great importance and evokes subtitle perceptions of the person's personality. Numerous authors [e.g. 2, 3] tried to fathom the meaning of nonverbal behavior. Overall, knowledge about the meaning of nonverbal behavior is broadly based on assumptions, while there is a lack of systematic research. Since a dominant perception might be useful in different scenarios of human-technology-interaction such as persuasion, many researchers tried to create an artificial entity with a dominant presence [e.g. 4–6]. A dominant personality is assumed to have a disposition to control others and is strongly related to power and status [7]. In the Interpersonal Circumplex [8, 9] this personality is represented by the dimension dominance (also called agency) and is characterized by a dominant and a submissive pole. Therefore, this research concentrates on nonverbal behavior that is perceived as dominant or submissive in the way Argyle defines it [8].

There are several nonverbal behaviors that are subsumed as being dominant or submissive and which were frequently used in previous studies in human-agent-interaction (HAI), for instance, hands placed on the hips, crossed arms, self-touch on the neck, sagittal head tilts, wide and expressive gestures. However, although these behaviors were frequently under investigation, the studies often lack a systematic approach and are thus of limited informative value with regard to the question how specific gestures affect person perception. With regard to HAI, symbolic gestures seem to have an influence on the perception of dominance. Gestures like putting the hand on the hips, which is also called Akimbo gesture [4, 5] or putting the hand in the neck [5] are assumed to have an effect on the perception of dominance or submissiveness. Due to the fact that both studies were not primarily interested in the person perception of those gestures, no experimental evidences could be drawn. However, the anecdotal findings regarding symbolic gestures with self-touch are in line with findings from HHI research [10] which suggest that people with high power and dominance are less likely to perform self-touch behavior. While the occurrence of self-touch often was investigated in negative situations and was related to nervousness [11], Harrigan et al. [12] found that people, who show more self-touching, were evaluated more positively. These inconsistent results suggest that the evaluation and perception of self-touch is diverse and may vary depending on the context of the interaction. A virtual agent displaying self-touching behavior was rated as more natural, warmhearted, agile and more committed, but also as more strained and aggressive [13]. However, self-touch was not evaluated empirically with regard to perceptions of dominance.

Additionally, the head-tilt seems to have an important influence on the perception of dominance. Mignault and Chaudhuri [6] as well as Lance and Marsella [14] investigated the effect of sagittal head-tilt based on different types of 3D models. Findings demonstrate that an upward head-tilt evokes dominance and tilting the head down is related to a submissive perception. However, in the presented stimuli of both studies the behaviors were devoid of any distracting cues (e.g. speech or other nonverbal behaviors), in order to investigate only the effect of head-tilt. In a study from Ravenet, Ochs and Pelachaud [15] users are asked to design a virtual agent's nonverbal behavior that is either perceived as dominant or submissive. Results empathize the effect of sagittal head-tilt, since an upward head-tilt was assumed to represent dominance and a downward tilted head seems to express submissiveness. Further on, user created nonverbal behavior with a larger spatial parameter in order to let the agent express dominance, while the created submissive behavior was characterized by a small spatial parameter. This findings are also well known from HHI, since it is assumed that powerful people tend to take up more space and have larger territories [16]. Therefore, expansive gestures evoke the perception of dominance [10, 17]. With regard to virtual agents taking up space does not have the same meaning compared to HHI, because the agent does not share the same physical room with its interlocutor. Although Ravenet et al. [15] demonstrated that the spatial parameter of nonverbal behavior is highly related to dominance and submissiveness; they did not investigate the user's perception, but asked the user to produce the agent's nonverbal behavior. Further on, Callejas, Ravenet, Ochs and Pelachaud [18] and Gebhard and Baur [19] demonstrated that the spatial parameter of nonverbal behavior as well as head-tilt is related to dominance and submissive perception. However, they did not evaluate the single movements individually. Hence, the effect of the individual nonverbal behaviors has to be further examined in HAI. In this study, we want to compare different nonverbal behaviors that theoretically relate to dominance. Therefore, we hypothesize that those behaviors that are widely used as or seen as dominant behaviors will be evaluated as more dominant compared to those behaviors widely used as or seen as submissive gestures (**H1**). And we further ask which behaviors are the most dominant and submissive ones (**RQ1**).

3 Cooperative Nonverbal Behavior

Even more than dominance, cooperative behavior is necessary in HAI, since many systems are designed to solve tasks in cooperation with the user. Humans are social animals and are cooperative by nature [20]. However, it is risky to cooperate with individuals, who do not set value on reciprocity. Thus, humans are able to detect nonverbal cues signaling commitment to cooperate [21]. A sender of (nonverbal) communication is able to express cooperative intent that the receiver can identify [22]. A cooperative personality in this sense is related to honesty, trustworthiness and reliability. One such signal of cooperativity seems to be expressivity. Schug et al. [23] showed that people, who are more cooperative, showed more expressive facial displays and that these expressions are not limited to positive ones. Other findings suggest that cooperativity is affected by the context of the interaction [24] and by the actual displayed nonverbal behavior (e.g. cooperation was increased, when individuals displayed happiness, while this was not the case for negative displays [25]). Although emotional expressivity seems to have an overall great influence on the perception of cooperativity, it is not proven whether this effect is limited to facial displays or can be expanded to gestures. Besides expressivity in general, there are some specific nonverbal behaviors believed to be cooperative signals such as lateral head-tilt. An initial study showed that individuals showing right head-tilts were evaluated more trustworthy than individuals showing left head-tilts or no head tilts [26]. Moreover, eye-gaze is a key-factor in theory of mind processes and can indicate the other individuals' believes [27] and thus increase cooperation. However, a straight gaze is also correlated to dominance [28]. Hence, the precise effect of gaze behavior on cooperativity and dominance in HAI has to be further examined. Although there are only limited studies examining the perception of virtual agents with regard to cooperativity, there is work on this topic in the field of human-robot interaction. The results by Stanton and Stevens [29] support the assumption that eye-gaze increases cooperation: a robot's gaze influenced ratings on trust (which is highly correlated to cooperativity) and participants' readiness to respond verbally. Counterintuitive results by Riek et al. [30] showed that humans cooperate more with robots that showed abrupt gestures than with those whose gestures were fluent. This demonstrates that (i) there is a general lack of systematic research on cooperativity expressed by nonverbal behavior and (ii) that expectations differ in HHI and HAI and therefore nonverbal cues can be interpreted differently. Some of the nonverbal cues that theoretically evoke a cooperative perception are also related to dominance (e.g. gaze and expressive gestures). Therefore, we strive to examine the interplay of dominance and cooperativity regarding these gestures. Based on these considerations, we hypothesize that those behaviors that are widely used as or seen as cooperative nonverbal behavior will be evaluated as more cooperative than those behaviors that are widely used as or seen as non-cooperative behavior (**H2**). Moreover, the evaluation of cooperativity correlates with the evaluation of dominance (**H3**). Further on, we ask what kind of nonverbal behaviors are perceived as signaling most cooperation (**RQ2**).

4 Method

4.1 Experimental Design and Independent Variables

In order to evaluate different gestures, we conducted an online study with a mixed factorial design. We tested four different categories of nonverbal behavior: dominant, submissive, cooperative and non-cooperative nonverbal behavior. We created eight behaviors for the dominance perception (4 *dominant* vs. 4 *submissive*) and 14 behaviors for the cooperativity perception (7 *cooperative* vs. 7 *non-cooperative*). Each behavior was shown while the agent said one out of seven sentences, which had an equal length and were all in the context of daily life support (e.g. "You are running out of milk and bread. Do you want to go shopping today?" or "The weather is fine and you don't have any appointments. Do you want to go out for a walk?"). Most of the behaviors were created using motion capturing with a post processing of bones, gaze and hand shape and were mapped on the embodied conversational agent *Billy (Social Cognitive System Group, Citec Bielefeld Germany)* while some behaviors were created with a key-frame editor. The virtual agent Billie is humanoid, male, more childish-looking and has a medium degree of realism (between cartoon and foto-realistic) (sf. Fig. 1). The four categories of nonverbal behavior were tested in a between-subjects design, while the different behaviors have been evaluated by repeated measures. Within one category of nonverbal behavior we created three video sets to avoid position effects. In these sets the position of the video and the combined sentence that was spoken during the gesture were pseudo-randomized (3 sets with different orders of gesture and sentence were conducted for each condition). During the online experiment participants saw a sequence of videos and rated the agent directly after each video. First, they were presented with a control video showing the agent with no nonverbal behavior and always the same opening sentence. Then participants saw additionally to the control video (in dependence of the experimental condition) four or seven videos with a combination of nonverbal behavior and sentence. Participants rated the agent directly after each video. In the last video the agent displayed one of the behaviors combined with a closing sentence ("Could you imagine that I support you in your everyday life?"), which also served as a behavioral measurement. In total we used 79 videos (1 control video, 66 behaviors & sentence combinations, 12 combinations of nonverbal behavior and behavioral question) in the survey. The videos have an average length of 8.55 s with a range from 7 s to 10 s.

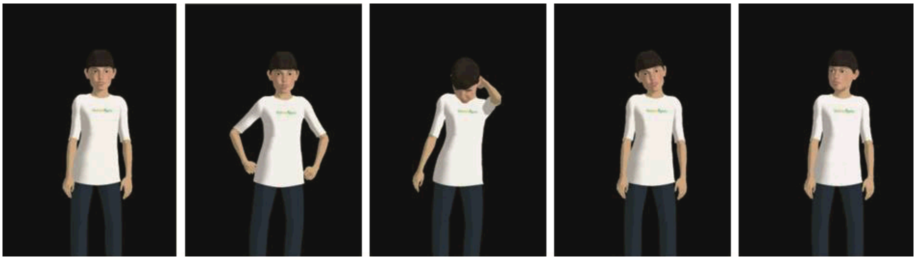

Fig. 1. Examples of the virtual agent Billie showing non-verbal behavior (control: no behavior, dominant: akimbo, submissive: neck-adaptor, cooperative: lateral flexion right and non-cooperative: gaze aversion)

4.2 Choice of Behaviors

Dominant and Submissive Behaviors. Most self-touches seem to be perceived as submissive, while there is also an emblem type of self-touch that seems to evoke a dominant perception. Thus, we examine the effect of previously used behaviors that are seen to be dominant (akimbo posture, [4, 5]) or submissive (touching neck and turning head down, [5]), respectively. Moreover, we created a closed arm gesture (crossing arms in front of his breast) as dominant gesture and an open arm gesture that seems to evoke a submissive perception. Further on, the position of the head seems to have an influence on the perception of dominance [e.g. 14]. Therefore, we investigate the effect of sagittal head tiles: turning the head up and turning the head down. Since taking up more space seems to be perceived as dominant [17], we test the range of the gesture. Therefore, a wide arm gesture with large radius and a small arm gesture with a small radius were created.

Dominant: akimbo posture, crossing arms, sagittal head up, large radius.
Submissive: neck-adaptor, arms open, sagittal head down, small radius.

Cooperative Behaviors. As mentioned above, the agent's gaze behavior seems to have an influence on its cooperativity evaluation [29]. Due to these findings, we investigate this effect in more detail with two different gaze behaviors: the agent turns his gaze towards the user vs. the agent averts his gaze from the user. Expressivity is highly related to cooperativity [23, 31]. Because smile as facial expression seems to have a main effect on the cooperativity perception, we took smile as facial expression into account. While the agent shows a big open smile with raised eye brows and open eyes in the cooperative condition, he expressed only a gentle smile without any eye movements in the non-cooperative condition. Most research concentrated on the effect of facial expressivity [e.g. 23, 25], while the effect of expressive gestures has not been examined. Therefore we created gestures with different degrees of expressivity. In the cooperative condition the agent shows many gestures with his arms while he says the sentence and in the non-cooperative condition fewer gestures with his arms are shown. To explore the effect of expressivity on cooperativity perception in more detail, we also tested the combination of expressive gesture and expressive facial expression. In order to imitate human behavior as best as possible, the movements of technical entities have to be fluent. While most developments concentrate on fluent movements, surprisingly, first results indicate that a more abrupt nonverbal behavior seems to be perceived as more cooperative [30]. In order to explore this effect in more detail, we created a fluent gesture with the agent's arms and created the same gesture with an abrupt performance. Beside gaze and expressivity a lateral head tilt seems to evoke a cooperative perception of the agent [26]. Until now only little is known about the particular effect of lateral head tilt (e.g.: Which side seems to evoke a stronger cooperativity evaluation? Does the position of the chin have an influence on the cooperativity evaluation?). Therefore we examine the effect of different types of a lateral head-tilt: Lateral head-tilt to the right side, lateral head-tilt to the left side vs. lateral head-tilt to the right side with a chin rotation and lateral head-tilt to the left side with a chin rotation.

Cooperative: gaze toward, expressive gesture, expressive mimic, expressive gesture and mimic, abrupt gesture, lateral flexion left, lateral flexion right.
Non-cooperative: avert one's gaze, non-expressive gesture, non-expressive mimic, non-expressive gesture and mimic, fluent gesture, lateral flexion chin left, lateral flexion chin right.

Additionally, all gestures were compared to a control gesture, where the agent does not show any nonverbal behavior. Example videos of the used nonverbal behavior can be found at the supplemented material.

4.3 Dependent Variables

Person perception of the agent was assessed using an ad-hoc scale with 14 items rated on a 5-pointed Likert Scale (1 = "strongly disagree" to 5 "strongly agree"). The scale contained general aspects like likability, warmth, but also specific items related to dominance and cooperativity. The ratings of each video of all participants (number of videos $n = 1134$, independent of the stimulus condition) were used in a factor analysis according to Horn [32] to expose underlying latent variables behind the 14 items. During parallel analysis those factors were identified whose empirical eigenvalues were higher than the eigenvalues that can be expected to be obtained from completely random data. Results suggested the extraction of three factors, which was the number of components that were retained in the final analysis. Principal component analysis (PCA) with promax rotation showed satisfying factor loadings (>.400; [c.f. 33]) for all variables and no cross loading of any variable. Thus, the three resulting factors of the PCA are:

1. *cooperative* (Cronbach's $\alpha = .941$; kind, likeable, open-minded, pleasant, trustworthy, I would ask the assistant for advice, I would work together with the assistant, The assistant might be able to help me, The assistant responds to me)
2. *dominant* (Cronbach's $\alpha = .838$; dominant, decisive and assertive)
3. *submissive* (Cronbach's $\alpha = .608$; submissive and reserved).

General rules suggest using subscales with Cronbach's alphas of at least .70. However, Cortina [34] discussed that a low number of items can artificially deflate alpha values. Thus, we decided to use also the factor submissive for further analyses, especially because the factor is a key concept with regard to the research question.

Since the overall setting of this study was the application of the agent as personal assistant for everyday-life support, an additional single item scale "Would you want me to support you in your everyday life?" was rated on a 5-pointed Likert Scale (1 = "strongly disagree" to 5 "strongly agree"). This item is assumed to be a behavioral measurement, in order to investigate whether participants prefer a dominant, submissive, cooperative or non-cooperative perceived agent to assist them in daily-life.

4.4 Participants and Procedure

A total of 222 subjects completed the online study. 32 stated technical difficulties with the videos, which is why those subjects were excluded. All further calculations were made with 190 participants (119 female, 69 male, 2 did not want to state their gender). Participants were equally distributed to the four conditions (dominant $n = 50$, submissive $n = 48$, cooperative $n = 43$, non-cooperative $n = 49$). On average participants were 26 years old ($M = 26.28$, $SD = 9.79$) and the age ranged from 16 to 78 years. After a first introduction participants stated their age and gender. Before they watched the first video, subjects were instructed to turn on the sound of their computers and to watch the following videos carefully. After that, the videos were presented. Participants were not able to turn to the next page until the whole video was shown. After they had seen the video, they were asked to evaluate the agent on the above presented scale. At the end of the questionnaire participants were debriefed and had the chance to take part in a raffle of gift cards from an online handler.

5 Results

5.1 Moderating Variables

In order to ensure that the evaluation of the agent's person perception is caused by the nonverbal gestures, analyses of age and gender effects were made. Therefore, three linear regression analyses with age on the person perception factors cooperative, dominant and submissive were calculated. Regression analyses revealed no significant effect of age on the agent's person perception. In addition, a MANOVA with gender as independent variable and person perception factors as dependent variables was conducted. Men and women did not significantly differ in their ratings on the factors cooperative and dominant, but they differed with regard to the factor submissive, $F(2,187) = 3.91$, $p = .022$, $\eta 2 = .04$. Men ($M = 3.14$, $SD = .91$) evaluated the agent significantly more submissive than women ($M = 2.77$, $SD = .87$). A Chi Square test showed that gender was equally distributed between the 12 different conditions and no significant differences in gender between those groups were found. Thus, the effect of gender on the submissive evaluation does not affect further calculations.

5.2 Comparison of Gestures Within the Conditions

To explore the effects of the different gestures within the four conditions, we conducted multiple repeated measures ANOVA's, with the single gesture as independent variable and the person perception factors (cooperative, dominant, submissive) as dependent variables. Each of the four conditions was analyzed separately. The dominant gestures do differ within their evaluation of dominance, $F(4, 49) = 16.83$, $p < .001$, $\eta 2 = .26$. While the control gesture and keeping the head up is less dominant than the akimbo posture and having the arms crossed, the akimbo posture was evaluated as more dominant than executing a gesture with a large radius. A second repeated measures ANOVA revealed a significant difference in submissive evaluation between all five gestures, $F(4, 49) = 15.41$, $p < .001$, $\eta 2 = .24$. Bonferroni post-hoc tests showed that the control gesture had been evaluated significantly more submissive than the akimbo posture, crossing the arms in front of the breast and doing a gesture with a large radius. The akimbo posture was perceived as significant less submissive compared to keeping the head up and a gesture with a large radius. In the same way, crossing the arms in front of the breast was less submissive in comparison to keeping the head up. With regard to cooperativity perception significant differences between the dominant gestures were observed, $F(4, 49) = 18.90$, $p < .001$, $\eta 2 = .28$. The gestures head up and large radius was evaluated significant more cooperative than all other gestures, but do not differ from each other. Further on, the control gesture was evaluated as more cooperative than crossing the arms (Table 1).

Comparing the submissive gestures, significant differences regarding the evaluation of dominance were found, $F(4, 188) = 7.62$, $p < .001$, $\eta 2 = .14$. The neck-adaptor was perceived as least dominant and differs significantly from the other four gestures. Referring to the submissive evaluation, significant differences between the submissive gestures were found, $F(3.41, 160.17) = 8.99$, $p < .001$, $\eta 2 = .16$. In contrast to the

Table 1. Means and standard deviations of dependent variables (dominant gestures)

Gesture	Dominant		Submissive		Cooperative	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control	2.36	.87	2.91	.90	2.55	.82
Akimbo posture	3.43	1.04	1.81	.95	2.54	.83
Crossing arms	3.09	1.09	2.03	1.06	2.28	.84
Sagittal head up	2.50	.89	2.55	.944	3.10	.79
Large radius	2.61	.93	2.37	1.04	3.04	.86

evaluation of dominance, the neck-adaptor was perceived as more submissive compared to keeping the arms open, moving the head down and doing a gesture with a small radius. Comparing the submissive gestures, significant differences in their cooperativity evaluations appeared, $F(3.34, 157.19) = 8.01$, $p < .001$, $\eta 2 = .15$. Post-hoc test using Bonferroni showed that the control gesture is less cooperative than speaking with open arms and doing arm movements with a small radius. Further on, neck-adaptor was also rated as less cooperative compared to the gesture with a small radius (Table 2).

Table 2. Means and standard deviations of dependent variables (submissive gestures)

Gesture	Dominant		Submissive		Cooperative	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control	2.36	.87	2.91	.90	2.55	.82
Open arms	2.41	.89	2.55	.79	2.85	.83
Neck-adaptor	1.92	.96	3.31	1.24	2.58	.82
Sagittal head down	2.65	1.00	2.49	.90	2.63	.77
Small radius	2.38	.79	2.47	.81	2.91	.90

In order to compare the cooperative gestures, further repeated measures ANOVA's were calculated. Results showed no significant differences between all eight gestures of the cooperative gesture in dominance evaluation, while the gestures do differ with regard to submissive ratings, $F(7, 294) = 3.37$, $p = .002$, $\eta 2 = .07$. Post-hoc analysis indicate that the perception of the control gesture were significant more submissive than turning the gaze toward the user, doing an expressive gesture and doing an expressive gesture combined with an expressive mimic. The cooperative gestures also differ significantly in cooperativity ratings, $F(5.25, 220.686) = 5.65$, $p < .001$, $\eta 2 = .12$. Participants evaluated the control gesture significantly less cooperative than an expressive gesture combined with an expressive mimic and both lateral head-tilts regardless of the side. Further on, turning the head toward the user was also rated as less cooperative compared to a lateral head-tilt to the left side (Table 3).

Within the last experimental condition no significant differences in dominance and submissive evaluation were obtainable, while the non-cooperative gestures do differ significantly in cooperativity ratings, $F(5.12, 245.73) = 9.32$, $p < .001$, $\eta 2 = .16$. Compared to the control gesture a non-expressive gesture, non-expressive mimic, the combination of non-expressive gesture and mimic, a fluent gesture and a lateral head-tilt with a chin rotation to the left as well as to the right side were evaluated as more

Table 3. Means and standard deviations of dependent variables (cooperative gestures)

Gesture	Dominant		Submissive		Cooperative	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control	2.36	.87	2.91	.90	2.55	.82
Gaze toward	2.65	.93	2.49	.83	2.69	1.04
Expressive gesture	2.64	.83	2.40	.65	2.96	.98
Expressive mimic	2.49	.84	2.42	.79	2.92	1.06
Expressive gesture and mimic	2.40	.77	2.55	.75	3.09	1.12
Abrupt gesture	2.57	.82	2.55	.78	2.87	.99
Lateral flexion left	2.33	.72	2.52	.84	3.07	1.02
Lateral flexion right	2.41	.73	2.55	.69	3.02	1.06

cooperative. Further on, participants perceived averting one's gaze as less cooperative in comparison with a non-expressive gesture, a non-expressive mimic, a fluent gesture and a lateral head-tilt with a chin rotation to both sides (Table 4).

Table 4. Means and standard deviations of dependent variables (non-cooperative gestures)

Gesture	Dominant		Submissive		Cooperative	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control	2.36	.87	2.91	.90	2.55	.82
Avert one's gaze	2.63	.92	2.42	.81	2.56	.83
Non-expressive gesture	2.67	.90	2.61	.98	2.95	.85
Non-expressive mimic	2.43	.92	2.63	.79	2.94	.88
Non-expressive gesture and mimic	2.44	.88	2.51	.84	3.09	.86
Fluent gesture	2.42	.99	2.51	.84	3.03	.90
Lateral flexion chin left	2.60	.92	2.42	.79	2.94	.79
Lateral flexion chin right	2.50	.95	2.48	.79	3.01	.91

5.3 Comparison of Gestures Between the Conditions

Since we assume differences between gestures of different experimental conditions, a MANOVA with experimental condition as independent variable and the three factors of person perception as dependent variable was conducted. Results did not reveal a significant main effect of experimental condition. Since earlier analyses yielded significant differences of the gestures within the experimental groups, further analyses, concentrating on the gestures with highest ratings, were made. Therefore, only the gestures akimbo, neck-adaptor, expressive gesture and mimic and the control gesture were compared. A second MANOVA revealed a significant main effects for dominance, $F(3, 189) = 22.92$, $p < .001$, $\eta 2 = .27$, submissive, $F(3, 189) = 82.18$, $p < .001$, $\eta 2 = .26$, and cooperativity, $F(3, 189) = 4.00$, $p = .009$, $\eta 2 = .06$. Post-hoc analyses showed significant differences between the akimbo posture and all other three gestures with regard to dominance evaluation. Further on, the dominant gesture was perceived as less submissive than the submissive, cooperative and non-cooperative gesture, while the perception of the neck-adaptor was more submissive than the cooperative gesture. With regard to cooperativity the combination of expressive gesture and mimic was rated as more cooperative than the dominant, submissive and non-cooperative gesture. In order to investigate whether the different gestures have an effect on the participants' willingness to use the presented agent as virtual assistant, a two-factorial ANOVA with the behavioral question as dependent variable and set as well as experimental condition as independent variables was conducted. No significant differences were obtainable. In hypothesis H3 we assume a correlation of cooperativity evaluation with dominance ratings. The results of a one-sided Pearson correlation indicate that cooperativity is significantly related to dominance, $r = .17$, $p = .011$.

6 Discussion

With regard to a successful human-agent-interaction, knowledge about the perception of virtual agent nonverbal behavior is of great importance. Overall, our research aims to design a virtual agent that will be perceived as cooperative, in order to enhance the human-agent-interaction. On the other hand in situations, where the agent has to be persuasive, it is necessary to evoke dominance. Therefore, we concentrate on the effect of nonverbal behavior on the agent's person perception. In an online study we evaluated different nonverbal behaviors that are theoretically related to dominance and cooperativity. When the different conditions with their entire spectrum were compared, our results did not support the hypotheses **H1** and **H2**. But with regard to both research questions (**RQ1 & RQ2**) the gestures within the groups differ from each other. Considering only the gestures with strongest effects, significant differences in person perception showed up. Therefore it is possible to evoke dominance and cooperativity, but careful decisions about the selected nonverbal behavior have to be made. With regard to dominance perception, having the arms crossed and the akimbo position are the most affective gestures. Taking up more space by executing a gesture with large radius was not perceived as more dominant than the other gestures. One possible explanation might be that the agent does not share the same physical space with the user, therefore the effect of taking up space, in order to signal power, is not as effective in human-agent-interaction as it can be in human face-to-face interaction. However, we found a tendency that the gesture with the large radius was perceived as more dominant than the one with the smaller radius. Regarding also prior findings [e.g. 14, 15], an effect of the gesture's spatial parameter can be assumed although this was not significant in our work which might be due to the within-subjects design. Hence, the strong symbolic behaviors such as akimbo or crossing the arms might have undermined the effect of the maybe subtler nature of the spatial dimension of behaviors.

Although various findings support the effect of sagittal head-tilts [6, 14], no significant differences in dominance were found. In contrast to previous findings, the upward head-tilt was perceived as more cooperative. Here, a limitation of the current setup might be responsible: Since the gestures have been tested in an online-study, the height of the screen in relation to the users eyes could not be controlled, while this was the case in the previous research [6]. Thus, in some cases the agent was presented below the eyes of the users, which might have led to the impression that the agent was looking at them, when he turns his head upward.

Moreover, self-touch with the hand in the neck and the gaze downward, evokes the most submissive perception and differs significantly from the other gestures. Since the most effective gestures (arms crossed, akimbo and neck-adaptor) are all emblems, a symbolic gesture seems to be the most effective one, with regard to dominance perception.

Findings for cooperativity, support the theoretical assumption [23, 31] that expressivity is related to cooperativity. While no differences between expressive gesture and expressive facial display could be shown, the combination of both was perceived as most cooperative. Similar to prior research [26], the lateral head-tilt did have an effect on perceived cooperativity, but no differences between the different head-tilt versions have been found. Thus, a lateral head-tilt regardless of the side or position of the chin, leads to a higher cooperativity perception. The gaze behavior seems to have an effect on cooperativity, because averting one's gaze was perceived significantly less cooperative. While the combination of expressive gesture and mimic was perceived as most cooperative, showing no gesture showed the lowest cooperativity values. Thus, expressivity evokes the strongest effect on cooperativity. In line with the assumption that cooperative and dominant behavior is related (**H3**), a significant correlation was found. However the effect was quite small, which might be explained by the diversity of the different behaviors and the strong effects of the symbolic gestures. In future studies the correlation of a dominant and a cooperative perception should be investigated by using only subtle behaviors like gaze or head movements.

Since only one kind of agent appearance was used in this study, the results are limited to humanoid characters and no generalization for agents with a different appearance can be made. Most of the nonverbal behavior was deduced from HHI, therefore it is important to investigate the effect of perceived human-likeness on the perception of those behaviors.

Our findings emphasize the effect of nonverbal gestures on the agent's person perception. Based on this systematical research, implications for the modeling of the agent's nonverbal behavior can be made. In order to investigate the effect of dominant, submissive, cooperative and non-cooperative gestures within specific contexts, further research has to be conducted. The gestures evoking the strongest effects in person perception, has to be tested in a realistic human-agent-interaction. Further on, the effect of those gestures on the user's behavior has to be investigated. Therefore, as a next step an interaction study will be conducted, in order to measure the persuasive effects of the dominant and submissive gestures. Since dominant behavior is known to be perceived as persuasive [1], an virtual agent showing dominant nonverbal behavior is assumed to evoke higher effects of persuasion. Similar research has to be done, in order to examine the effect of cooperative nonverbal behavior on the user's intention to cooperate in human-agent-interaction.

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References

1. Burgoon, J.K., Birk, T., Pfau, M.: Nonverbal behaviors, persuasion, and credibility. Hum. Commun. Res. **17**, 140–169 (1990)
2. Burgoon, J.K., Guerrero, L.K., Manusov, V.: Nonverbal signals. In: Knapp, M.L., Daly, J.A. (eds.) Handbook of Interpersonal Communication, 4th edn., pp. 239–280. Sage, Thousand Oaks (2012)
3. Givens, D.B.: The nonverbal dictionary of Gestures, Signs and Body Language Cues. Center for Nonverbal Studies Press, Spokane (2002)
4. Ball, G., Breese, J.: Relating personality and behavior: posture and gestures. In: Paiva, A.C. (ed.) IWAI 1999. LNCS, vol. 1814, pp. 196–203. Springer, Heidelberg (2000)
5. Richardson, R., Devereux, D., Burt, J., Nutter, P.: Humanoid upper torso complexity for displaying gestures. Int. J. Adv. Robot. Syst. **9**, 1–9 (2012)
6. Mignault, A., Chaudhuri, A.: The many faces of a neutral face: head tilt and perception of dominance and emotion. J. Nonverbal Behav. **27**, 111–132 (2003)
7. Cashdan, E.: Smiles, speech, and body posture: how women and men display sociometric status and power. J. Nonverbal Behav. **22**, 209–229 (1998)
8. Argyle, M.: Bodily Communication, 2nd edn. Methuen, New York (1988)
9. Gurtman, M.B.: Exploring personality with the interpersonal circumplex. Soc. Personal. Psychol. Compass. **3**, 601–619 (2009)
10. Carney, D.R., Hall, J.A., LeBeau, L.S.: Beliefs about the nonverbal expression of social power. J. Nonverbal Behav. **29**, 105–123 (2005)
11. Neff, M., Toothman, N., Bowmani, R., Fox Tree, J.E., Walker, M.A.: Don't scratch! Self-adaptors reflect emotional stability. In: Vilhjálmsson, H.H., Kopp, S., Marsella, S., Thórisson, K.R. (eds.) IVA 2011. LNCS, vol. 6895, pp. 398–411. Springer, Heidelberg (2011)
12. Harrigan, J.A., Kues, J.R., Steffen, J.J., Rosenthal, R.: Self-touching and impressions of others. Personal. Soc. Psychol. Bull. **13**, 497–512 (1987)
13. Krämer, N.C., Simons, N., Kopp, S.: The effects of an embodied conversational agent's nonverbal behavior on user's evaluation and behavioral mimicry. In: Pelachaud, C., Martin, J.-C., André, E., Chollet, G., Karpouzis, K., Pelé, D. (eds.) IVA 2007. LNCS (LNAI), vol. 4722, pp. 238–251. Springer, Heidelberg (2007)
14. Lance, B., Marsella, S.C.: Emotionally expressive head and body movement during gaze shifts. In: Pelachaud, C., Martin, J.-C., André, E., Chollet, G., Karpouzis, K., Pelé, D. (eds.) IVA 2007. LNCS (LNAI), vol. 4722, pp. 72–85. Springer, Heidelberg (2007)
15. Ravenet, B., Ochs, M., Pelachaud, C.: From a user-created corpus of virtual agent's non-verbal behavior to a computational model of interpersonal attitudes. In: Aylett, R., Krenn, B., Pelachaud, C., Shimodaira, H. (eds.) IVA 2013. LNCS, vol. 8108, pp. 263–274. Springer, Heidelberg (2013)
16. Remland, M.S.: The implicit ad hominem fallacy: nonverbal displays of status in argumentative discourse. J. Am. Forensics Assoc. **19**, 79–86 (1980)
17. Burgoon, J.K., Dunbar, N.E.: Nonverbal expressions of dominance and power in human relationships. In: Manusov, V., Patterson, M.L. (eds.) The Sage Handbook of Nonverbal Communication, pp. 279–298. SAGE Publications Inc., Thousand Oaks (2006)
18. Callejas, Z., Ravenet, B., Ochs, M., Pelachaud, C.: A computational model of social attitudes for a virtual recruiter. In: Proceedings of the 2014 International Conference on Autonomous Agents and Multi-agent Systems, pp. 93–100 (2014)
19. Gebhard, P., Baur, T., Damian, I.: Exploring interaction strategies for virtual characters to induce stress in simulated job interviews. In: Proceedings of the 13th International Conference on Autonomous Agents and Multi-agent Systems (AAMAS 2014), pp. 661–668 (2014)

20. Tomasello, M.: The ultra-social animal. Eur. J. Soc. Psychol. **44**, 187–194 (2014)
21. Brown, W.M., Moore, C.: Smile asymmetries and reputation as reliable indicators of likelihood to cooperate: an evolutionary analysis BT. In: Shohov, S.P. (ed.) Advances in Psychology Research, vol. 11, pp. 59–78. Nova Science Publishers, Huntington (2002)
22. Reed, L.I., Zeglen, K.N., Schmidt, K.L.: Facial expressions as honest signals of cooperative intent in a one-shot anonymous Prisoner' s Dilemma game. Evol. Hum. Behav. **33**, 200–209 (2012)
23. Schug, J., Matsumoto, D., Horita, Y., Yamagishi, T., Bonnet, K.: Emotional expressivity as a signal of cooperation. Evol. Hum. Behav. **31**, 87–94 (2010)
24. De Melo, C.M., Carnevale, P., Gratch, J.: The impact of emotion displays in embodied agents on emergence of cooperation with people. Presence Teleoper. Virtual Environ. **20**, 449–465 (2011)
25. Stouten, J., De Cremer, D.: "Seeing is Believing": the effects of facial expressions of emotion and verbal communication in social dilemmas. J. Decis. Mak. **23**, 271–287 (2010)
26. Krumhuber, E., Manstead, A.S.R., Kappas, A.: Temporal aspects of facial displays in person and expression perception: the effects of smile dynamics, head-tilt, and gender. J. Nonverbal Behav. **31**, 39–56 (2006)
27. Kurzban, R.: The social psychophysics of cooperation: nonverbal communication in a public good game. J. Nonverbal Behav. **25**, 241–259 (2001)
28. Adams, R.B.J., Kleck, R.E.: Effects of direct and averted gaze on the perception of facially communicated emotion. Emotion **5**, 3–11 (2005)
29. Stanton, C., Stevens, C.J.: Robot pressure: the impact of robot eye gaze and lifelike bodily movements upon decision-making and trust. In: Beetz, M., Johnston, B., Williams, M.-A. (eds.) ICSR 2014. LNCS, vol. 8755, pp. 330–339. Springer, Heidelberg (2014)
30. Riek, L.D., Rabinowitch, T.-C., Bremner, P., Pipe, A.G., Fraser, M., Robinson, P.: Cooperative gestures: effective signaling for humanoid robots. In: 2010 5th ACM/IEEE International Conference on Human-Robot Interaction (HRI), pp. 61–68 (2010)
31. Krumhuber, E., Manstead, A.S.R., Cosker, D., Marshall, D., Rosin, P.L., Kappas, A.: Facial dynamics as indicators of trustworthiness and cooperative behavior. Emotion **7**, 730–735 (2007)
32. Horn, J.L.: A rationale and test for the number of factors in factor analysis. Psychometrika **30**, 179–185 (1965)
33. Velicer, W.F., Peacock, A.C., Jackson, D.N.: A comparison of component and factor patterns: a monte carlo approach. Multivar. Behav. Res. **17**, 371–388 (1982)
34. Cortina, J.M.: What is coefficient alpha? An examination of theory and applications. J. Appl. Psychol. **78**, 98–104 (1993)

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