First Impressions: Users' Judgments of Virtual Agents' Personality and Interpersonal Attitude in First Encounters

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Abstract. In first encounters people quickly form impressions of each other's personality and interpersonal attitude. We conducted a study to investigate how this transfers to first encounters between humans and virtual agents. In the study, subjects' avatars approached greeting agents in a virtual museum rendered in both first and third person perspective. Each agent exclusively exhibited nonverbal immediacy cues (smile, gaze and proximity) during the approach. Afterwards subjects judged its personality (extraversion) and interpersonal attitude (hostility/friendliness). We found that within only 12.5 seconds of interaction subjects formed impressions of the agents based on observed behavior. In particular, proximity had impact on judgments of extraversion whereas smile and gaze on friendliness. These results held for the different camera perspectives. Insights on how the interpretations might change according to the user's own personality are also provided.

Keywords: first impressions, personality traits, interpersonal attitude, empirical evaluation, nonverbal behavior, camera perspectives.

1 Introduction

In first encounters our initial impressions of another person may determine whether there are subsequent encounters and, importantly, what expectations we bring to future encounters [1]. Therefore, it is not surprising that individuals attempt to manage the impressions that others form of them [2]. First impressions can be shaped by both *static* individual characteristics and stereotypes, such as height, clothing or, generally, visual appearance [3,4,5] and by *dynamic* characteristics such as verbal [6] and nonverbal behavior [1,4,7]. These characteristics differ in the way they can be controlled. Individuals, for example, can carefully plan how to present themselves visually in a first

encounter, but then it may be difficult to have full control over all nonverbal cues [2] during the interaction. In fact, one of the most interesting properties of nonverbal cues in social interaction is that they are irrepressibly impactful. Try as they might, people cannot refrain from behaving nonverbally. If, for example, they try to be as passive as possible, they are likely to be perceived as unexpressive, inhibited, withdrawn, and uptight [2]. Therefore, nonverbal behavior plays a fundamental but, at the same time, subtle role in the dynamics of impression management. After just a few seconds of observing someone's nonverbal behavior, we can pick up with a remarkable accuracy a variety of information including, for instance, a person's skills [8], sexual orientation [9], political view [10] and, personality or attitudes towards other persons [4,11,12,13]. Intelligent agents are not immune to these judgments. During initial encounters with agents, such as the receptionist at a virtual museum in Fig. 1, users form impressions of them based on exhibited nonverbal behavior.

During even the most fleeting interactions, perceivers rapidly form impressions of another's personality traits [14], which can be defined as broad themes in behavior, thoughts, and emotions that distinguish one person from another and endure over time [5]. The most used theory of personality, the so called "Big 5" model [15], is based on the results of factor analyses that demonstrate that five factors are sufficient for providing the best compromise between explanatory power and parsimony. These 5 factors are: extraversion, neuroticism, agreeableness, conscientiousness and openness to experience. Accurate first impressions of personality traits can be formed [11] and extraversion (the extent to which people are outgoing, gregarious, talkative, and sociable) seems to be one of the easiest trait to pick up [14] through rapid interpersonal judgments of nonverbal behavior [13], including interpersonal distance, smile, gaze and posture [4,7,12].

Compared to personality, attitudes are subject to a greater degree of variation over time. Interpersonal attitudes are essentially an individual's conscious or unconscious judgment of how they feel about and relate to another person while interacting with them [4]. Argyle identifies two fundamental dimensions of interpersonal attitudes that can account for a great variety of non-verbal behavior: affiliation (ranging from friendly to hostile) and status (from dominant to submissive) [4]. Affiliation, in particular, can be broadly characterized as liking or wanting a close relationship. Most categories of nonverbal behavior that can be used to regulate this aspect fall under the category of *"immediacy behavior"*. These include proximity, gaze, and certain facial expressions such as smiles. Immediacy is similarly defined as the degree of perceived physical or psychological closeness between two people [12]. Greater affiliation or immediacy, for example, is conveyed by standing close instead of far, having eye contact and smiling in interpersonal encounters [4,12].

These theoretical underpinnings suggest that the specific set of nonverbal cues composed by smile, gaze and proximity can be used to manage impressions of both "long-term" (personality traits) and "more immediate" (interpersonal attitudes) individual characteristics. We will exploit this duality in the context of initial greeting encounters between humans and agents. The main research questions behind our work are the following. (1) What is the role of smile, gaze and proximity when managing impressions of extraversion and affiliation? (2) How do those cues combine in user interpretations?

(3) Does the interpretation of nonverbal behavior change according to users' own personality?

2 Related Work

Expression of personality and interpersonal attitudes. There has been considerable previous work developing expressive virtual characters capable of reflecting a personality consistent with the verbal and nonverbal cues exhibited. Neff et al. exploited the extraversion [16] and neuroticism [17] traits of the Big Five model in multimodal characters evaluating the effects of verbal and nonverbal behavior in personality perception studies. Similarly, Paiva et al. [18] presented a model of personality, based on the Big 5, aimed at creating distinct traits that in turn can influence an agent's cognitive and behavioral processes. Pelachaud et al. proposed a real-time backchannel selection algorithm for choosing the type and frequency of backchannels to be displayed according to the personality of the virtual character used [19]. Regarding interpersonal attitudes, Gillies and Ballin [20] concentrated on a general framework based on Argyle's status and affiliation model for animating nonverbal behavior of virtual characters in improvisational visual media production and expressing interpersonal attitudes toward to one another. Finally, Lee and Marsella [21] proposed an analysis framework of nonverbal behavior for modelling side participants and bystanders. They based their analysis on the Argyle's status and affiliation model and considered agents' interpersonal relationships, communicative acts and conversational roles.

These works dealt with either incorporating personality traits [16,17,18,19] or interpersonal attitudes [20,21] separately. The virtual agents were mainly designed for face-to-face interactions or interactive drama. Our work focuses on interpretations of nonverbal behavior when both personality (extraversion) and attitude (affiliation) are expressed at the same time. Furthermore, our agents are exclusively exhibiting nonverbal behavior in the formative moments of the first virtual encounter between the user and agent.

Impression management and nonverbal behavior. Heylen et al. [22,23] showed how a realization of a simple communicative function (managing the interaction) could influence users' impressions of an agent. They focused on impressions of personality (agreeableness), emotion and social attitudes through different turn-taking strategies in human face-to-face conversations applied to their virtual agents in order to create different impressions of them. In [24], Fukayama et al. proposed and evaluated a gaze movement model that enabled an embodied interface agent to convey different impression to users. They used an "eyes-only" agent on a black background and the impressions they focused were affiliation (friendliness, warmth) and status (dominance, assurance). Similarly, Takashima et al. [25] evaluated the effects of different eye blinking rates of virtual agents on the viewers subjective impressions of friendliness, nervousness and intelligence.

The work of Heylen et al. emphasizes the "side-effect" of different nonverbal choices in the realization of a communicative function (i.e. turn taking), whereas our purpose is to intentionally manipulate specific agents' immediacy cues (smile, gaze and proximity) and see how users interpret them. The interest is on the impressions they form

of personality/affiliation but also keeping an eye on extra types of judgments that could arise. As opposed to Fukuyama et al., we are using full body virtual agents to exhibit our nonverbal behavior (in particular to be able to exhibit proximity cues), which is not narrowed down to specific behaviors such as eyes-only gaze [24] or eyes blinking [25].

Impact of user's personality on agent evaluation. Bickmore et al. [26] showed that an agent's use of small talk increased trust in it for extraverted users, but for introverted users it had no effect. According to Von Der Pütten et al.[27], users' personality influences their subjective feeling after the interaction with a virtual agent, as well as their evaluation and actual behavior. The effects of an agent's behavior also depends on the personality of the user, in particular people with high values in agreeableness and extraversion (among other findings) judged agents more positively compared to people with high values in shyness. Kang and colleagues suggested that users' personality traits crucially affect their perceptions of virtual agents. They explored how users' shyness [28] and Big 5 personality traits [29] are associated with their feelings of rapport when they interacted with different versions of virtual agents capable of exhibiting nonverbal feedback. In [28] they found that more anxious people (high in social anxiety, i.e. shyness) felt less rapport, while feeling more embarrassment, when they interacted with a *non-contingent* agent. On the other hand, in [29] more agreeable people felt strong rapport when interacting with a rapport agent embodying agreeable features (i.e. nonverbal *contingent* feedback while listening).

As opposed to the typology of studies investigating the benefits of matching-up user and agent personality (e.g. [30]), we aim to understand the role of a user's personality when interacting with a virtual agent, similar to [28,29]. However, in our context we are interested in the possible blending effect that user personality may have on snap judgments of personality/affiliation after observations of solely body language in the very first moments of interaction.

3 Experimental Design

In order to evaluate users' impressions of a greeting agent's extraversion and affiliation in a first encounter we conducted an empirical study in which subjects approached a series of agents with their own avatar. The agents exclusively exhibited a set of nonverbal immediacy cues that were systematically manipulated during approaches of 12.5 seconds each (the length has been chosen after a prior validation study described later in this section). The study was split in two trials differing only in the camera perspective used (1st or 3rd). Our hypotheses, for both trials, were the following:

- **H1**: The amount of extraversion that subjects attribute to a greeting agent **(a)** depends on the unique combination of smile, gaze and proximity it exhibits towards the subject during the first 12.5 seconds of the interaction and **(b)** is further moderated by the subject's own personality.
- **H2**: The amount of friendliness that subjects attribute to a greeting agent **(a)** depends on the unique combination of smile, gaze and proximity it exhibits towards the subject during the first 12.5 seconds of the interaction and **(b)** is further moderated by the subject's own personality.

3.1 Apparatus and Stimuli

The context was a virtual main entrance of a museum. The scene always started with the subject's avatar (AVATAR) outside, in front of automatic sliding doors, and the greeting agent (AGENT) standing inside, close to a reception desk watching a computer screen. Figure 1 (left) shows this setting in first person perspective when the approach has already started. To conduct the study in a fully controlled fashion and have subjects

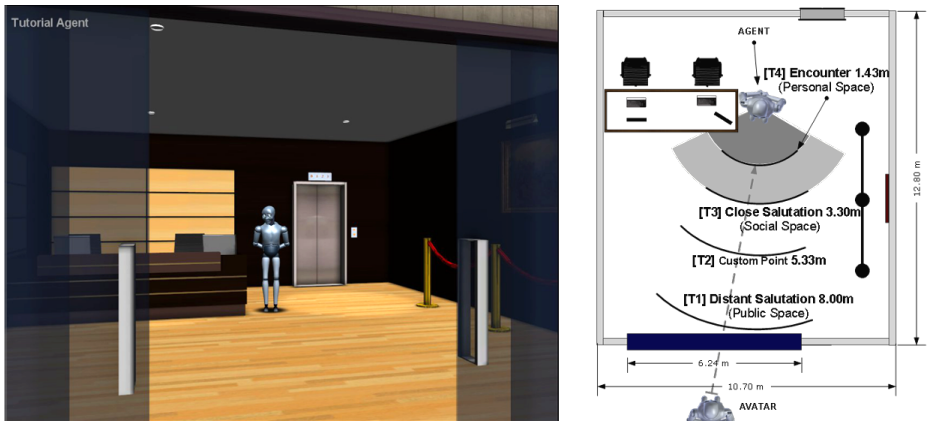

Fig. 1. The setting of our study with the user's avatar entering the virtual museum entrance in first person mode and the greeting agent waiting inside. The schematic shows points where specific behaviors were exhibited by the agent during the avatar's approach.

focusing exclusively on the AGENT, their level of interaction was limited to deciding when to start the approach by pressing a specific button. This triggered a locomotion behavior of their AVATAR towards the AGENT that automatically ended when the AVATAR reached the encounter space. We limited the control of the AVATAR to this simple choice to ensure that all approaches were performed in the same way across all conditions and subjects. To control for possible bias of the agent's visual appearance on the impressions formed, the agents were always graphically identical and not wearing any clothes. We used a male gendered model having human resemblance. Body movements were generated with procedural animation techniques and included a default eye blinking behavior and a slight body oscillation movement. All AGENTS were *always* holding the arms at the back with hands unclenched (as shown in Fig. 1 (left)). To give the idea of interaction with different entities we assigned them the name "Agent" followed by a progressing number shown at the beginning of each approach and in the top-left corner of the screen.

Our independent variables were **smile** (no vs. yes), **gaze** (low % vs. high %) and **proximity** (no approach vs. approach). We conducted an informal manipulation check (N = 10, 2 females and 8 males, every subject tested both 1P and 3P perspectives) where we deployed a simplified version of the 3D environment and the agent exhibiting each behavior separately to verify that differences between the levels were correctly perceived by subjects within a certain time limit. The exact timing and location for triggering each behavior was based on Kendon's observations of human greetings (distant and

close salutation model) [31] and Hall's proxemics theory [32]. Figure 1 (right) shows a schematic top view of the scene with the AVATAR and the AGENT in their initial positions. The grayed dotted line shows the path followed by the AVATAR, black arcs are points were specific behaviors were exhibited. The description on top of them includes: a short reference name (in square brackets), the corresponding stage in Kendon's model (except for the custom point T2), the distance (in meters) from the AGENT and the name of the corresponding space in Hall's model (when overlapping). The arc without description was added to manipulate gaze (as described later) and the gray circular sections represents the AGENT's social and personal space according to Hall's proxemics theory. The duration of 12.5 seconds for each approach came naturally from the two models chosen: It was the time needed by the AVATAR to walk from its initial position (slightly off T1) to the *encounter* point (T4), that coincided with Hall's *personal space* boundary (humans usually do not allow others to cross this space, in particular during a first encounter). The duration was also determined by the AVATAR's speed, that was fine-tuned in the manipulation check to make sure that subjects were able to observe all the nonverbal cues exhibited by the AGENT, while keeping a walking speed for the AVATAR as much natural as possible.

We created a *baseline behavior* for the AGENT that was exhibited across all conditions of the study when the AVATAR approached it. This consisted of watching the computer screen at the beginning with both head and eyes towards it, gazing at the AVATAR for 2 seconds when it was at T1 (8m), looking back at the screen moving only the eyes and, finally, gazing at the AVATAR at T3 (3.30m). The AVATAR always stopped at T4 (1.43m). In a smiling condition the AGENT started smiling at T1. The *"high %"* gaze was obtained with a 2 seconds eye glance at T2. It follows that the difference between "low %" and "high %" gaze conditions was simply related to their duration, in the former the AGENT looked at the subject's AVATAR for a shorter time compared to the latter (in the manipulation check we validated whether subjects were able to distinguish between the two). The *"approach"* condition was simply a step towards the AVATAR when it was at T3[6] keeping the arms at the back. Since we had eight different conditions, we adopted a latin square design to partially counter balance the treatment order and avoid first order carryover effects [33].

3.2 Measures

A summary of our measures is provided in Tab.1. Agent Extraversion was assessed using 4 items from the Saucier's Mini-Markers [34] set of adjectives for measuring the Big 5. Two with positive (bold and extroverted) and two with negative (shy and withdrawn) valence. For the analysis the negative valence items scores were flipped and averaged with the positive ones to provide a final score. As exploratory variables, we included the ***Extra Impressions*** formed by subjects right after every approach and a measure of ***Agent Likeability***.

[6] Here the T2 in the published proceedings was a typo.

MEASURE	QUESTION	POINTS	LEFT ANCHOR	RIGHT ANCHOR
Agent Extraversion	I think the agent is [bold, extraverted, shy, withdrawn]	9	Extremely inaccurate	Extremely accurate
Agent Friendliness	How hostile/friendly has the agent been towards you?	9	Extremely hostile	Extremely friendly
Agent Likeability	Would you want to continue the interaction with this agent later?	5	No, definitely not	Yes, definitely
Subject Personality	Extraversion, agreeableness, neuroticism (using Saucier's items)			
Extra Impressions	Subjects asked to write adjectives that came to their minds			

Table 1. Summary of measures. Points refer to number of points on Likert scales.

3.3 Participants and Procedure

We had 32 participants for each trial recruited via public announcements in our university campus and the surrounding city. In the 1P trial we had 20 males and 12 females representing 11 nationalities[7]. In the 3P trial we had 19 males and 13 females representing 9 nationalities. In both trials, subjects were aged 21-60 with 63% in the 21-30 range. All subjects were well educated and most were at least familiar with computer science and psychology. They were led to a dedicated room at our university facility, seated in front of a 19" LCD monitor, instructed about the procedure and shown a tutorial for familiarization. After this introduction, the investigator monitored the session from an adjacent room. The session consisted of (1) observing each approach and then filling a form that included all measurements except the subject personality, (2) completing the personality inventory and (3) inserting demographic data in separate web forms. Finally, the investigator debriefed them.

3.4 Quantitative Results

We conducted separate statistical analyses for the two trials, further comparison between the two is provided in Sec. 4. For each trial, we conducted a mixed-design ANOVA for each measure (Agent Extraversion and Friendliness) with smile, gaze, and proximity as a within-subjects factors and subject extraversion, agreeableness and neuroticisms as between-subjects factors. We used a full factorial model except that we omitted interactions among the between-subject factors. In order to use the three subject personality traits as between factors, for each measured trait we split our population in tertiles, thus resulting in 3 levels "*low*, *medium* and *high*" for each trait. For quantitative variables this has been shown to be a better practice [35] compared to the median split [36] (*"high"* and *"low"*). Main effects of interactions between factors are tested using Bonferroni adjustments for multiple comparisons. Effect sizes for all comparisons ranged from **.02** to **.73**. Table 2 provides a summary of our quantitative findings for both trials.

[7] As part of the demographic information, we asked participants to select the nation that most represented their cultural identity from a list of all countries in the world.

TRIAL	AGENT EXTRAVERSION	AGENT FRIENDLINESS
1P	Proximity (.000)	Smile (.000)
	Gaze (.082)	Gaze (.049)
	Gaze * S. Extraversion (.052)	Gaze * S. Agreeableness (.026)
	Smile * S. Agreeableness (.084)	Smile * Proximity * S. Agreeable. (.031)
3P	Proximity (.000)	Smile (.000)
	Smile * S. Extraversion (.025)	Gaze (.002)
	Gaze * Proximity * S. Extra. (.057)	Smile * S. Extraversion (.002)
	Smile * Proximity * S. Neuro. (.070)	Smile * S. Agreeableness (.064)

Table 2. A summary of our results. The first column indicates the camera perspective of the trial, second and third refer to our two measures: agent extraversion and friendliness. For each measure relevant main effects and factor interactions, including significance level (p-values in parenthesis), are reported. All main effects positively affected extraversion and friendliness. The factor interactions had different influence depending on the subject personality. The abbreviation S. stands for *"subject"*.

First Person Perspective (1P)

Agent Extraversion. The analysis revealed a significant main effect of proximity on agent level of extraversion, $F(1, 25) = 34.75, p < .001$; *approaching* agents were rated higher than *non-approaching* agents (**H1-a supported**). The main effect of gaze was near significant, $F(1, 25) = 3.28, p = .082$. The main effect of smile was not significant, and there were no significant factor interaction effects. However, the factor interaction between gaze and subject extraversion was near significant, $F(2, 25) = 3.35, p = .052$, as was the factor interaction between smile and subject agreeableness, $F(2, 25) = 2.74, p = .084$, therefore **H1-b** is **rejected**.

Agent Friendliness. There was a significant main effect of smile on agent level of friendliness, $F(1, 25) = 34.75, p < .001$; *smiling* agents were rated higher than *not smiling* ones (**H2-a supported**). There was a significant main effect of gaze, $F(1, 25) = 4.27, p < .05$, and a significant factor interaction between gaze and subject agreeableness, $F(2, 25) = 4.2, p < .05$. This would suggest that the effect of gaze depended on the subject personality. A main effects follow-up analysis revealed that gaze affected the ratings of agent friendliness for *low* agreeable subjects, but not *medium* and *high* ones (**H2-b is partially supported**). The main effects of gaze were further analyzed by pairwise comparisons: for subjects with *low* level of agreeableness, the ratings of agent friendliness in the *low gaze* condition were significantly lower than the *high gaze* condition ones. There was also a significant factor interaction between smile, proximity and subject agreeableness, $F(2, 25) = 4.02, p < .05$. The follow-up analysis of proximity main effects was not significant. On the other hand, smile affected the ratings of agent friendliness at all levels of proximity and for all the three subject personality levels, except for *low* agreeable subjects when the agents were *not approaching* them.

Agent Likeability. We ran the same mixed-design ANOVA for the ratings of agent likeability. There was a significant main effect of smile on agent likeability $F(1, 25) = 20.03$, $p < .001$; subjects preferred to continue the interaction with *smiling* agents.

Third Person Perspective (3P)

Agent Extraversion. Results of the analysis revealed a significant main effect of proximity on agent level of extraversion, $F(1, 25) = 67.20, p < .001$, and this was rated

higher in the *approach* condition (**H1-a supported**). The main effects of smile and gaze were not significant. There was a significant factor interaction between smile and subject extraversion, $F(2, 25) = 4.27$, $p < .05$. This would suggest that the effect of smile depended on the subject personality. However, a main effects follow-up analysis revealed that smile affected the ratings of agent extraversion for *low* extraverted subjects, but not *medium* and *high* ones (**H1-b is partially supported**. A main effects analysis indicated that for subjects with *low* level of extraversion the ratings of agent extraversion when *not smiling* were significantly different from the condition with *smiling*. The factor interaction between gaze, proximity and subject extraversion was near significant, $F(2, 25) = 3.22$, $p = .057$, as was the factor interaction between smile, proximity and subject neuroticism, $F(2, 25) = 2.97, p = .070$.

Agent Friendliness. There were significant main effects of smile and gaze on agent level of friendliness (Smile. $F(1, 25) = 49.07$, $p < .001$; Gaze. $F(1, 25) = 12.33$, $p < .005$); friendliness was rated higher either when the agent was *smiling* or when the *amount* of *gaze* was *high* (**H1-a supported**). The main effect of proximity was not significant. There was a significant factor interaction between smile and subject extraversion,
$F(2, 25) = 8.00$, $p < .005$. This would suggest that the effect of smile depended on the subject personality. However, a main effects follow-up analysis revealed that smile affected the ratings of agent friendliness for *medium* and *high* extraverted subjects, but not *low* ones (**H2-b is partially supported**). The main effects of smile were further analyzed: for subjects with *medium* level of extraversion the ratings of agent friendliness when *not smiling* were significantly lower than conditions with *smiling* agents. For subjects with *high* level of extraversion the ratings of agent friendliness when *not smiling* were significantly different from the conditions with *smiling*. The factor interaction between smile and subject agreeableness was near significant, $F(2, 25) = 3.08$, $p = .064$, as was the factor interaction between gaze, proximity and subject agreeableness, $F(2, 25) = 2.85, p = .077$.

Agent Likeability. There were significant main effects of smile and gaze on agent likeability (Smile. $F(1, 25) = 41.35, p < .001$; Gaze. $F(1, 25) = 9.91, p < .005$); subjects preferred to continue the interaction with agents *smiling* and *gazing* at them *more*. The factor interaction between smile and subject extraversion was near significant, $F(2, 25) = 2.68, p = .088$, as was the factor interaction between proximity and subject extraversion, $F(2, 25) = 2.73, p = .084$.

3.5 Qualitative Results

For the analysis of "Extra Impressions" we grouped synonymous adjectives into different categories. For each of these, we counted the number of different subjects that used adjectives belonging to that category. In both trials subjects' extra impressions revealed that the agent was judged as "bored, annoyed" (Tot. 1P = 24, 3P = 15) mainly when *not smiling* and *not approaching* or exhibiting a *short* amount of *gaze*, "careless, dismissive, uninterested" (Tot. 1P = 12, 3P = 23) when *smiling* but *gazing* for a *short* amount of time and vice versa. Impressions of "aggressive, stern, challenging and unfriendly" were formed (TOT. 1P = 15, 3P = 18) when the agents were *approaching*. In general,

subjects judged the agents as "kind, polite, gentle" (Tot. 1P = 20, 3P = 6) and used common human characteristics to define their extra impressions, thus perceiving the agents as believable even though all our behaviors were pre-scripted. Only a few subjects used adjectives such as "fake, deliberated, agent, scripted" (Tot. 1P = 2, 3P = 6) in the specific condition when he was *approaching*, *not smiling* and *gazing* briefly. Furthermore, adjectives such as "authority, powerful, leader, achiever, ambitioned" were used (Tot. 1P = 17, 3P = 10) mainly when *approaching* and "professional, business-like, precise" (Tot. 1P = 12, 3P = 10) when *not smiling* regardless of proximity and gaze levels.

4 Discussion and Future Work

For the first person perspective (1P), H1-a and H2-a were supported. We found that the amount of extraversion and friendliness that subjects attributed to our agents depended on unique combinations of smile, gaze and proximity that they exhibited. In particular, agents *approaching* the subject's avatar were judged as more extraverted than agents *not approaching*, regardless of gaze amounts or whether they were *smiling* or *not*. Smile had a main effect on judgments of friendliness. These results seem quite intuitive but it is important to note that proximity had absolutely no effects on judgments of friendliness even though qualitative impressions of "aggressive, stern, challenging and unfriendly" were formed when subjects judged *approaching* agents. Therefore, we had a sharp distinction between interpretations of proximity and smile. When it came to judging extraversion proximity had the highest weight, whereas smile dominated the impression formation of friendliness. This is an important result if we consider that smile and gaze can also be used to express personality traits (extraversion) as suggested by previous social psychology literature in human-human nonverbal communication [4,13].

The relation between subject personality and behavior interpretation is harder to explain since H1-b was rejected and H2-b only partially supported. The effect of gaze on agent friendliness partially depended on subject agreeableness. *Low* agreeable subjects interpreted more gazing friendlier compared to less gazing. We didn't get significant results for *medium* and *high* agreeable subjects. According to the personality inventory we used, those who scored *low* in agreeableness are likely to be cold, unsympathetic, rude and harsh as opposed to the warm, kind and cooperative highly agreeable people. We think that this might reflect results of a previous study arguing that low sociable people tend to be more accurate in judging others in zero-acquaintance situations [37]. The factor interaction between gaze and subject extraversion was near significant for the agent level of extraversion, and again only for *low* extraverted subjects (shy, quiet, withdrawn).

Gaze is also involved in a possible explanation for the factor interaction between smile, proximity and subject agreeableness when judging the agent friendliness. In fact, smile had effect on all the subjects except the *low* agreeable group in the particular conditions when the agents were *not approaching*. This would suggest that this group gave more importance to gaze in that case. Although non-significant, a similar trend was observed also in the judgments of agent extraversion.

H1-a and H2-a were also supported when moving to third person perspective and with quite similar results. Again agents *approaching* the subject's avatar were judged as

more extraverted than agents *not approaching* them, regardless of smile and the amount of gaze they gave. The effects of gaze on agent friendliness were clearer and didn't depend on subjects' personality. They interpreted agents gazing more at them as friendlier. Smile also led to higher ratings of friendliness, except for *low* extraverted subjects that formed impressions of extraversion rather than friendliness when judging a smiling agent. A possible explanation could be still related to the higher accuracy of judgments that low sociable people express, therefore interpreting smile as a cue of higher extraversion in that case. Another reason could be the great variability we had in the subjects level of extraversion (2.25 to 8.13) whereas the level of agreeableness was more compact (5.00 to 8.25). In general, the role of smile and proximity was clearly separated also for this trial.

Our findings indicate that results in social psychology research on the assessment of personality traits and attitudes on the basis of nonverbal behavior [7,1,4] do translate to the context of user-agent interaction. In particular, outcomes of using nonverbal immediacy [12] are preserved in virtual encounters.

Despite a stronger effect of gaze in 3P, results in both trials are similar, thus suggesting that camera perspective does not alter the way our set of nonverbal cues was interpreted. This result reflects our expectations, even though we couldn't formulate a precise hypothesis a priori due to the lack of previous work investigating this particular aspect. Similar research dealt more with immersive virtual environments [38] explored with head mounted displays [39,40] but not with 3D virtual environments experienced in the same way as in our study or in many of the works mentioned in Sec. 2. We think that, in addition to impact the virtual agents community, this result has also implications in the study of human social psychology. It is interesting to see how users in the 3P trial were still able to form impressions of a virtual character (the agent) when this was exhibiting nonverbal cues towards another virtual character shown on the screen (their avatar) and not directly towards them as in 1P, thus putting them-selves completely in the role of a virtual entity external to their body.

Furthermore, in both trials results of agent likeability mirrored those of friendliness, thus agents smiling and gazing more also resulted in more approachable and likeable agents. This is not surprising considering that one of the advantages of immediacy cues is obtaining a more favourable impression [12], but it also foresees that friendliness was considered more important than extraversion by subjects when they had to decide whether to continue the interaction or not.

Some limitations should be considered. When we looked at the relationship between subjects' personality and their interpretations we found interesting trends supporting that personality acted as moderator. However, these speculations are limited by the statistical significance of the results and the specific population obtained. The ideal body of subjects would have consisted of a balanced population with personality equally distributed in the three groups for each trait. Furthermore, we are aware that cultural identity has influence on behavior interpretation and, in particular, in the 1P we had a high variety in the population. Finally, we may also want to look further into possible gender differences.

Future work will continue in two directions. First, we will build on these results exploiting the impact of impression management on users. The goal is to understand

whether initial impressions of an agent impact users' desire to interact with it again. Secondly, we will consider the user personality and investigate possible matches with the agent's personality, interpersonal attitude and the combination of the two.

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