

Impact of Virtual Environment Design on the Assessment of Virtual Agents

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ABSTRACT

Virtual agents usually come in a virtual environment that can be designed in various ways which might affect users. This paper presents a study that examines whether the design of the virtual environment has an impact on the assessment of the virtual agent and the interaction. In a virtual job interview training, participants interacted with a virtual interviewer that behaved exactly the same, but the background and lighting conditions were manipulated. Our results indicate that the environmental design affects the assessment of the interviewer as well as the interview process.

KEYWORDS

design in virtual environment, assessment of virtual agents

ACM Reference Format:

Tanja Schneeberger, Anke Hirsch, Cornelius König, and Patrick Gebhard. 2019. Impact of Virtual Environment Design on the Assessment of Virtual Agents. In *ACM International Conference on Intelligent Virtual Agents (IVA '19)*, July 2–5, 2019, PARIS, France. ACM, New York, NY, USA, 3 pages. <https://doi.org/10.1145/3308532.3329455>

1 INTRODUCTION

The environment gives us additional information about a person, e.g., her role, status, personality or values [7] and might affect our assessment of this person. Also in human-like interactions with virtual agents, the environment where the virtual agent is presented might influence the perception of it.

In this work, we examine the environmental impact during a simulated job interview, in which the agent has the role of a job interviewer. In our study, we assess if mood, assessment of the interview and interviewer, self-assessed interview performance, and room influence are affected by wall color and light conditions in the space where a job interview is conducted (green, bright lighting vs. red, dim lighting, compared to neutral; Fig.1).

2 BACKGROUND AND RELATED WORK

2.1 Technology-driven Job Interview Training

The MACH system provides access to social skills training [9]. In their study, the authors presented an application in the context of

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IVA '19, July 2–5, 2019, PARIS, France

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ACM ISBN 978-1-4503-6672-4/19/07...\$15.00

<https://doi.org/10.1145/3308532.3329455>

a job interview training. Using MACH leads to a larger externally rated interview performance increase compared to a control group that used conventional methods to prepare job interviews.

The TARDIS system [1] simulates job interviews. Based on this system, a virtual job interview training with the focus on nonverbal behavior was designed [12]. Users conduct a simulated interview with a virtual agent while the computer analyzes the user's nonverbal behavior and provides real-time feedback. The authors showed that their virtual job interview training leads to better interview performance and that the training has a positive influence on interview anxiety. An extended version of this system, was created in the EMPAT project. There, the job interview training includes a complete experience in a 3D environment and develops a scenario-based serious game simulation platform [4, 5].

Social training systems can enhance social skills in job interviews. However, none of the presented systems is taking aspects like different wall color and lighting conditions into account. Therefore, we present a study examining the effects of these two aspects in a virtual environment where a job interview takes place.

2.2 Effects of Color and Lighting

Color and lighting of the environment seem to have an impact on peoples' affect, behavior, and cognition. Red ambient color seems to have a negative effect on the affect of clinical patients [6] and seems to be distracting while performing numerical and conceptual comparison tasks [11]. Moreover, the color red seems to function as a dominance cue [8]. On the other hand, green ambient color seems to have a positive relaxing effect on patients [6] and causes customers to spend more time and buy more in a shop [2]. Regarding lighting, a bright lighting has increasing effects on peoples' mood and performance in problem-solving tasks [10] and on the time spent in a shop [2]. Moreover, it leads to a controlled and reflected way of self-awareness [16] and self-regulation [16], which are two important skills for, e.g., job interview situations.

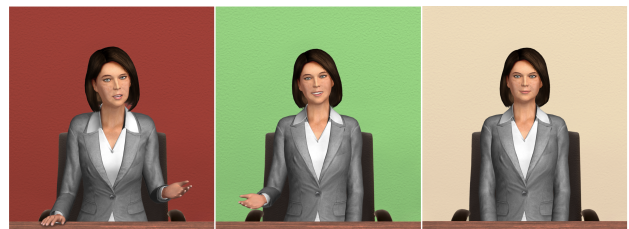


Figure 1: The virtual job interviewer in the three different environments.

In this study, we vary between a green, bright room and a red, dim room in which a job interview takes place.

Hypothesis 1: Participants will feel more comfortable in the green room showing higher values in the mood questionnaire.

Hypothesis 2a and 2b: Participants in the red condition will assess the interview (2a) and the interviewer (2b) as more negative.

Hypothesis 3: Participants in green room self-evaluate their interview performance higher.

Hypothesis 4: Participants should perceive the red room more influencing than the green room.

3 METHOD

3.1 Participants and Design

Sixty student participants (27 male) were randomly assigned to one of the experimental conditions (red wall color, green wall color) or the control condition (neutral wall color). They were aged between 18 and 32 years ($M = 24.00$ years, $SD = 3.08$ years) studying on average in the seventh semester ($SD = 4.47$). On average, participants attended three job interviews ($SD = 2.54$) before our experiment.

We used a between-subjects design with two experimental conditions and one control condition to test our hypotheses. Participants in the red condition, got the interview in a room with a red wall color ($R = 200, G = 31, B = 31$) and a dim lighting. In the green condition, the interviewer was sitting in front of a green wall ($R = 125, G = 218, B = 120$) with bright lighting. The control condition was conducted in a room with the neutral wall color beige ($R = 230, G = 206, B = 178$) and normal lighting.

3.2 Procedure

After welcoming the participant in the experimenter's room, the experimenter explained the procedure and participants filled in the demographic questionnaire as well as the informed consent form. Afterward, participants were introduced to the job interview role-play mentioning that the interviewer is a virtual agent. Participants were equipped with a head-mounted microphone and instructed to speak loudly and clearly during the interview. The experimenter accompanied the participants to the office where the interview was conducted, which the participants entered alone. After the participant sat in front of the interviewer and connected the microphone, the job interview started. At the end of the interview, the virtual interviewer referred to the questionnaires that the participant had to fill out. Participants left the room again to be debriefed by the waiting experimenter. The procedure took around 30 minutes.

3.3 Material and Experimental Setup

In this study, participants had a job interview with an interactive virtual agent (Fig.1) with a natural human appearance and verbal as well as nonverbal dialogue skills [15].

The job interview was scripted with the VisualSceneMaker [3], a real-time execution and authoring tool for modeling verbal and non-verbal behavior of virtual agents. The interview included standard questions like the presentation of the resume, biographical, situative, and social questions, e.g., exploring participants' proactivity, strengths, and weaknesses, organizing ability, critical faculties.

The interview took place in a lab at a university chair, looking like a typical office with a size of about 20m². Lighting conditions in

the lab were kept constant by closing the shades and switching on the ceiling-mounted light that consists of four equally distributed fluorescent tubes (PHILIPS Master TL-D Super 80, color temperature 4000K - neutral white). The room light was not dimmed.

The experimental setup consisted of a PC running MS Windows 10™ (Intel Core i7 CPU@3.5GHZ, 16GB Memory, NVIDIA GTX 990 graphics cards) connected to a Toshiba REGZA 47Z3030D LCD TV screen (108cm diagonal, color temperature 4000K - neutral white, color space IEC 61966-2-4) showing the virtual interviewer at a realistic size in a 3D environment. The LCD's brightness and its color saturation was reduced by 25% in order to match the room's ambient lighting conditions. No other standard color settings were changed. All built-in color manipulation algorithms were disabled.

3.4 Measures

Mood was assessed with the two scales Tension - Anxiety and Vigor - Activity of the Profile of Mood States (POMS) questionnaire [14] that we translated in German.

Assessment of the interview was done with four scales of the German version of the Selection Procedural Justice Scale (SPJS) [17]. 17 items were taken and adapted from the scales Openness, Treatment, Propriety of Questions, and Procedural Fairness.

Assessment of the interviewer was done with four own items asking if the job interviewer behaved well towards the participant, performed well, represented the chair and was likable.

Self-assessed interview performance was examined with the Chance to Perform scale taken and adapted from the German version of the Selection Procedural Justice Scale (SPJS) [17].

Influence by the room was assessed with two items adapted from [11] asking for influence on interview performance and mood.

All items had to be answered on a scale ranging from 1 (*strongly disagree/not at all*) to 5 (*strongly agree/extremely*).

4 RESULTS

Overall, the MANOVA showed a significant difference between the three groups, red, green and neutral room, Pillai's trace = .40, $F(12,106) = 2.17, p < .05, \eta_p^2 = .27$. Results for the ANOVAS examining differences for the single variables are presented in Table 1.

Hypothesis 1 stated that participants will feel more comfortable in the green room and show corresponding values in the questionnaire assessing the mood. We found no significant difference between the groups on the Tension-Anxiety scale but for the scale Vigor-Activity. Participants felt less vigor and active in the red room. Hence, hypothesis 1 was partially supported by our data.

Hypothesis 2a proposed that participants in the red condition should rate the interview more negatively. This could be supported by our data. Hypothesis 2b posited that participants in the red condition should rate the interviewer more negative than in the green condition what could be supported by our data.

Hypothesis 3 proposed that participants' self-assessed interview performance is higher in the green condition compared to the red one. The ANOVA showed a significant effect between the groups. Participants felt a higher self-assessed interview performance in the green room which supported hypothesis 3.

Hypothesis 4 posited that participants in the red condition should find the red room more influencing than the green room. The

Table 1: Descriptives and Results for the Single ANOVAS (including η_p^2) and Helmert Contrasts.

Self-assessed variable	Condition			ANOVA and Helmert Contrast			
	red <i>M (SD)</i>	green <i>M (SD)</i>	neutral <i>M(SD)</i>	Main effect <i>F</i>	η_p^2	red vs. green & neutral <i>p</i>	green vs. neutral <i>p</i>
Tension - Anxiety	1.97 (0.51)	1.83 (0.56)	1.70 (0.62)	$F(2,57) = 1.11$	.04	.189	.475
Vigor - Activity	2.90 (0.70)	3.04 (0.65)	3.39 (0.43)	$F(2,57) = 3.44^*$	.11	.063	.067
Interview	3.39 (0.57)	3.92 (0.48)	3.85 (0.60)	$F(2,57) = 5.67^{**}$	.17	.002^{**}	.667
Interviewer	2.85 (0.86)	3.46 (0.65)	3.17 (0.88)	$F(2,57) = 3.03^*$	.10	0.37^*	.251
Interview performance	2.10 (0.81)	2.59 (0.96)	2.66 (0.55)	$F(2,57) = 2.89^*$	.10	0.20^*	.780
Influence by the Room	2.65 (0.99)	2.48 (0.86)	1.89 (0.97)	$F(2,57) = 3.46^*$	.11	.076	.055

Note. All scales ranging from 1 to 5. $n_{\text{green}} = 21$, $n_{\text{red}} = 20$, $n_{\text{neutral}} = 19$. * $p < .05$, ** $p < .01$, *** $p < .001$. Results from one-sided ANOVAS. Helmert Contrasts two sided.

ANOVA for Influence by the Room revealed a significant difference between the three groups. The red room was perceived to be the most influencing what supported hypothesis 4.

5 DISCUSSION

The aim of this study was to find out whether the design of a virtual environment affects the assessment of a virtual job interviewer and interview. Participants conducted an interview with an interactive virtual 3D agent in a virtual office where the background color and the lighting were varied (red with dim lighting, green with bright lighting, neutral). Our results show that the design of the virtual environment affects mood, the assessment of the interview and interviewer, the self-assessed interview performance as well as the assessment of the influence by the room. Likewise in a real environment [6], our findings show that also in a virtual environment a red room design has negative unpleasant effects on people. Regarding the assessment of the interview, the green room causes the participants to feel more politely, openly, respectfully and fairly treated by the virtual interviewer. These results are consistent with [2] and [10]. According to findings by McCloughan et al., hostility is greater under warm than under cold color temperature [13]. As a result, it is understandable that the interviewer in our study is assessed more negatively in the red condition than in the green one. Also, we could find that in the green room participants had the impression that they are better presenting themselves than those in the dim red condition (cf. [16]). With our data, showing that participants rated the red room as the most influencing one, we can support that a red office was rated to be distracting [11].

6 CONCLUSION

The results of this study indicate that for the development of virtual training systems, the color and lighting of the virtual environment are crucial aspects as they can affect the assessment of the virtual agents in this environment. We could show that a virtual job interviewer and the job interview is perceived less favorable in a dim red room compared to a bright green and neutral one. Moreover, the virtual environment influences users' self-assessed performance and mood. Participants had the impression that they are better presenting themselves in the green bright room and the neutral room than those in the dim red condition.

ACKNOWLEDGMENTS

This work is partially funded by the German Ministry of Education and Research (BMBF) within the EmpaT project (16SV7229K).

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