Get One or Create One: The Impact of Graded Involvement in a Selection Procedure for a Virtual Agent on Satisfaction and Suitability Ratings

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Abstract.

N = 86 participants were either confronted with a predefined virtual agent, or could select a virtual agent from predefined sets of six or 30 graphical models, or had the opportunity to self-customize the agent's appearance more freely. We investigated the effect of graded user involvement in the selection procedure on their ratings of satisfaction with the agent and perceived task suitability. In a second step, we explored the psychological mechanism underlying this effect. Statistical analyses revealed that satisfaction with the chosen virtual agent increased with the degree of participants' involvement in terms of more choice, but not in terms of self-customization. Furthermore, we show that this effect was driven by the perceived likeability, attractiveness, and competence of the agent. We discuss implications of our results for the development of a virtual agent serving as a virtual assistant in a smart home environment.

Keywords: technology acceptance, virtual agents, customization, smart home

1 Introduction

Over the last decades, a notable increase in the presence of intelligent virtual agents in daily life as assistive technologies and in smart home contexts could be observed (cf. [1,2]). Such agents provide information services, help in accessing information from the web, or allow for setting up the technical environment through natural language dialogues, and thereby facilitate daily life. However, to date people hold rather negative attitudes towards robots and other assistive technologies in the home context [3,4]. Therefore, it is of major importance that virtual assistants satisfy users' expectations, and elicit positive attitudes towards them. To increase users' acceptance of innovative technologies, psychological aspects and users' needs have to be taken into account [5,6]. Accordingly, we propose a user-centered approach by engaging

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end users actively in the selection and customization process of virtual assistants. In the present study, we focus on the visual appearance of a virtual agent that would be deployed as a fitness coach within a smart home environment. We explored the effect of user involvement on subsequent evaluations. We did so by investigating whether users would prefer to select the virtual agent's appearance from a predefined set of graphical models or whether they would prefer to self-customize the appearance more freely. Above and beyond, we shed light on the psychological underpinnings of user involvement.

2 Related Work and Background

2.1 The relevance of psychological involvement and self-investment

Phillips and Zhao [7] have identified the lack of user involvement in the selection process of assistive devices as one determinant of technology abandonment. Previous work in the context of assistive technologies has likewise emphasized the need to involve the user to increase satisfaction with technical devices and reduce rejection [8]. Marketing research has shown that consumers prefer products that are tailored to their preferences and that customization has positive effects on people's attitudes towards products [9]. According to Deci and Ryan's *self-determination theory* [10], providing choice or involving people in the decision process on how to carry out a task increases their intrinsic motivation which leads to more satisfaction with the result. Festinger's *dissonance theory* [11] explains the enhancement of satisfaction by two paradigms: The *free-choice-paradigm* proposes that people who are confronted with a difficult choice, will always augment the value of the choose choice, while reducing the value of the un-chosen one, in order to rationally justify their choice. The *effort-justification-paradigm* proposes that when people spent a lot of effort on a task, they value the result more, because they need to justify the effort they put in it. In the domain of marketing research, this effect has been coined the *IKEA effect* [9]. It shows that involving individuals in the product design and customization process leads to a cognitive bias in which consumers place a disproportionately high value on products they partially created. Regarding assistive technologies, these social psychological theories indicate that giving users a choice and the feeling of participation in a selection and customization process is fundamental with regard to the acceptance of the resulting product. We can conclude from self-determination theory and dissonance theory that asking users to invest their time and cognitive resources in certain assistive technologies by involving them in the selection and customization process might lead to a strong identification with the resulting product and result in a greater valuation of the developed technical device.

2.2 The mediating role of agent perception and evaluation

The present research aimed to shed light on the psychological processes underlying the effect of involvement in the selection of a virtual agent on satisfaction with the

agent and the perceived suitability for its task. We predicted that the effect should be mediated by user perceptions of the agent. Drawing on previous research on the perception of intelligent virtual agents, the following dimensions are deemed particularly relevant for this mediation process: On the one hand, there is extensive research on perceived agent *likeability and attractiveness* (cf. [12,13]). Furthermore, *warmth and competence*, the two core dimensions of social cognition [14], play a key role in impression formation about humans and nonhuman entities [15]. The dimension of warmth captures friendliness and positive intentions; the dimension of competence captures economical and educational success [14]. Finally, the degree to which persons perceive a virtual agent being *similar to them* seems to be an interesting potential mediator [16]. Going beyond existing research on the perception and evaluation of virtual agents, we propose a mediating function of each of the described variables, perceived likeability, attractiveness, warmth, competence, and similarity, for the relationship between user involvement and satisfaction with the agent as well as the rating of agent's task suitability. As there exists no systematic investigation of variables that mediate the effects of graded involvement of users on their attitudes and cognition (cf. [2]), this is an important step to close this gap.

2.3 Relevant dimensions of agent appearance

A vast body of research documents that the appearance of robots and virtual agents strongly influences their evaluation (e.g. [12], [15]). Research on social categorization emphasizes the relevance of *gender* and *age* as social categories used to form an impression [17]. Furthermore, *hairstyle* seems to be a salient facial cue, especially for determining a target's and even a robot's gender [18,19]. To take this into account, we systematically varied gender, but also age and hairstyle of the virtual agents that were used as stimuli in our study.

3 Present Experiment

Although the relevance of involvement of the end users in the development of assistive technologies is widely acknowledged ([7], [9]), the optimal level of user involvement in the development of virtual agents is yet under-researched. Therefore, we investigate the influence of different degrees of involvement by conducting an experiment with four conditions. One condition represents the control condition without involvement, where participants are confronted with a predefined virtual agent. In the first experimental condition, participants are offered limited choice as they can choose their preferred virtual agent out of a predefined set of six graphical models. In the second experimental condition, they are involved to a greater degree by offering them the choice between 30 predefined models. In the third condition, participants can self-customize the appearance of the virtual agent by individually selecting different graphical features. Primarily, we argue that when people are involved in the selection and customization process for a virtual agent as their smart home assistant, they invest their time and cognitive resources in this process, which

they do not when they are confronted with a predefined virtual agent. We assume this self-investment to lead to a more positive evaluation of the chosen or self-customized agent and finally to result in higher satisfaction and in the perception of greater suitability of the agent. Accordingly, we predict a ranking order regarding satisfaction and suitability from the control condition ascending through the three experimental conditions (*Hypothesis 1*). Specifically, we expect the grade of cognitive investment that is needed to choose one agent out of a set of six models to be notably lower than to choose one agent out of 30 models. This assumption fits observations from neuropsychological testing, indicating that six items are easily manageable when it comes to information processing [20]. Second, we argue that self-customization allows individuals to experience a sense of accomplishment following agent creation which increases their valuation of the result. Simply choosing an agent might lead to a far weaker cognitive bias (cf. [8]). Thus, we expect the strongest effects of involvement in the condition where the participants self-customize the intelligent virtual agent. Furthermore, based on the literature about agent perception and social cognition (cf. [12,13,14,15]) we hypothesize that the relationship between freedom of choice in the selection procedure and satisfaction with the virtual agent as well as the rating of agent's suitability for its task would be mediated by the evaluation of the resulting agent in terms of likeability, attractiveness, warmth, competence and participants' perceived similarity to the virtual agent (*Hypothesis 2*). Furthermore, we predict that persons generally request customization of a virtual agent for a smart home context and the possibility to design it themselves (*Hypothesis 3*).

3.1 Method

Participants and design 86 participants (52 females, 31 males, three participants who did not indicate their gender; M_{age} = 25.20; SD_{age} = 8.59; [16; 64]) took part in the online study. The link was shared using social media and snowball sampling. Participants were randomly assigned to one of four conditions resulting from a between subjects design with selection procedure as the independent variable (selection procedure: "no choice" vs. "choice of one out of six virtual agents" vs. "choice of one out of 30 virtual agents" vs. "self-customization of the virtual agent").

Procedure After giving written informed consent, participants were asked to imagine living in a smart home that included a virtual fitness coach. The virtual agent would instruct them while learning new exercises, it would remind them of training goals, and provide information on their general health status. Depending on the condition, participants were then asked to evaluate a predefined, self-chosen, or self-customized virtual agent.

Stimuli Forty-eight virtual agents were built with the Autodesk® Character Generator. Eight "basis" agents were built manually, taking into account both gender and age of the virtual character. The further procedure was automated so that different hair colors and hair lengths were added automatically to each of the basis agents at a time. The resulting virtual agents were pretested in a *pilot study*: Eight participants (two females, five males, one participant who did not indicate his/her gender; M_{age} = 26.62;

SD_{age} = 7.17; [22; 44]) selected their first, second and third preference of a virtual agent that should serve as a fitness coach. The most favored agents were chosen for the main study.

Experimental manipulation In *Condition 1*, participants were confronted with the virtual agent that reached the highest preference score in the pilot study (see Figure 1, no. 24). In *Condition 2*, the six virtual agents that reached the six highest preference scores in the pilot study were presented (Figure 1, no. 1, 7, 10, 11, 18, 24). In *Condition 3*, participants chose their most favored virtual agent out of a set of 30, including the stimuli used in Conditions 1 and 2, plus 24 additional agents (see Figure 1). In *Condition 4*, participants could customize the virtual agent by choosing gender, age (i.e., childhood, adolescence, middle age, old age), hair color (i.e., blond, brown, gray) and length (i.e., short, long) of the agent. Finally, a picture of the resulting agent was displayed, and participants were still able to change attributes again. The possible results included all agents presented in the other conditions and 18 additional agents.

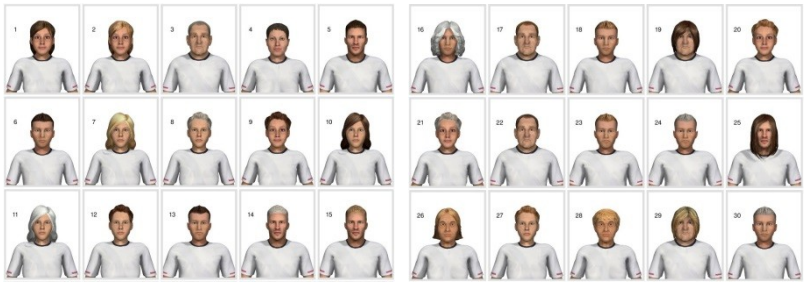

Fig. 1. Stimuli presented in the study.

Measures As *dependent variables*, participants indicated how satisfied they were with the virtual agent, and reported perceived task suitability of the agent. As *potential mediators*, participants evaluated the agent on warmth, competence, likeability, attractiveness, and similarity to themselves. General expectations towards a smart home assistant were assessed by using five items: 'An assistant should…' – 'merely fulfill its task.', 'look visually appealing.', 'be visually unique.', 'be distinct.', 'be customizable.'. As a *control variable*, we measured prior experience with virtual agents using two items. Seven-point Likert scales (from 1 = not at all, to 7 = very much) were used to record participants' responses. Finally, participants indicated their gender, age, and level of education.

5 Results

Descriptive statistics revealed that 40% of the participants in Condition 2 chose agent no. 10. Another 20% of the participants chose no. 7, which is the same agent with blond instead of brown hair. In Condition 3, 21.7% of the participants chose agent no. 1, while 26% of the participants chose agent no. 10, and another 26% of the participants chose no. 7. In Condition 4, 38.5% of the participants ended the design

process with agent no. 10, and another 7.7% of the participants ended the process with no. 7.

To test *Hypothesis 1*, a multivariate analysis of covariance (MANCOVA) was conducted to analyze the effect of the selection procedure on satisfaction with the virtual agent and agent's task suitability. Participants' gender, age, level of education, and prior experience with virtual agents were included as covariates. Subsequently, a planned contrast analysis was carried out, which compared each category of selection procedure to the previous category. Descriptive statistics are summarized in Table 1.

Table 1. Means and standard deviations of satisfaction with the virtual agent and agent's task suitability as a function of condition.

Condition	no choice	1 out of 6	1 out of 30	self-customized	total
Satisfaction Mean (*SD*)	3.29 (1.90)	4.88 (1.20)	5.61 (1.12)	4.96 (1.37)	4.84 (1.53)
Suitability Mean (*SD*)	4.71 (0.91)	5.04 (1.40)	5.83 (0.98)	5.25 (1.45)	5.26 (1.29)

Satisfaction with the virtual agent There was a significant main effect of selection procedure on the degree of satisfaction with the virtual agent after controlling for gender, age, level of education, and prior experience with virtual agents ($F(3, 75) = 7.59$, $p < .001$, $\eta^2 = .23$), but no significant effects of the covariates, all Fs$(1, 75) \leq 2.56$, *ns.* Following the principle of parsimony [21], the planned contrast analysis was carried out without covariates, and revealed that in Condition 1, participants were significantly less satisfied than in Condition 2, $t(18.97) = -2.84$, $p < .05$, $r = .05$ after correcting for unequal variances. Participants in Condition 2 were again significantly less satisfied than in Condition 3, $t(45.99) = -2.18$, $p < .05$, $r = .31$. However, participants' satisfaction did not differ significantly between Conditions 3 and 4, $t(43.93) = 1.79$, $p = .08$.

Task suitability of the virtual agent Contrary to *Hypothesis 1*, there was no main effect of the selection procedure on the degree of task suitability of the virtual agent after controlling for gender, age, level of education, and prior experience with virtual agents, $F(3, 75) = 2.25$, $p = .09$. However, level of education was significantly negative ($F(1, 75) = 4.52$, $p < .05$, $\eta^2 = .06$, $r = -.25$), and prior experience with virtual agents was significantly positive related to agent's task suitability, $F(1, 75) = 5.62$, $p < .05$, $\eta^2 = .07$, $r = .20$. There were no gender nor age effects, Fs$(1, 75) \leq 1.43$, *ns*.

Mediation by the evaluation of the virtual agent To test *Hypothesis 2*, the mediating role of the evaluation of the virtual agent measured by five concepts (likeability, attractiveness, warmth, competence, and perceived similarity) between selection procedure and satisfaction with the virtual agent was established by conducting a mediation analysis using the PROCESS SPSS application provided by Hayes [22] with 5000 bootstrap samples. There were significant indirect effects of selection

procedure on satisfaction with the virtual agent through perceived likeability (b = .26, BCa CI [.10, .52]), attractiveness (b = .08, BCa CI [.01, .22]), and competence (b = .09, BCa CI [.01, .27]). There were no indirect effects through warmth and similarity. As no direct effect of selection procedure on agent's task suitability was found, we did not conduct a further mediation analysis for this dependent variable.

Participant's expectations towards a virtual agent To evaluate the general expectations of the participants towards a smart home assistant (*Hypothesis 3*), one-sample t-tests against the neutral scale midpoint (scale value = 4) were conducted using Bonferroni correction for multiple testing. Figure 2 shows significant deviations from the mean value indicating that participants in general favor a smart home assistant that is customizable ($t(85)= 5.93$, $p < .001$, $r = .54$), and distinct, $t(85)= 3.10$, $p < .01$, $r = .32$. They further favor an assistant that merely fulfills its task ($t(85)= 3.43$, $p < .01$, $r = .35$), and that looks visually appealing, $t(85)= 9.02$, $p < .001$, $r = .70$. They are rather neutral with regard to visual uniqueness of the agent, $t(85)= -.80$, $p = .43$.

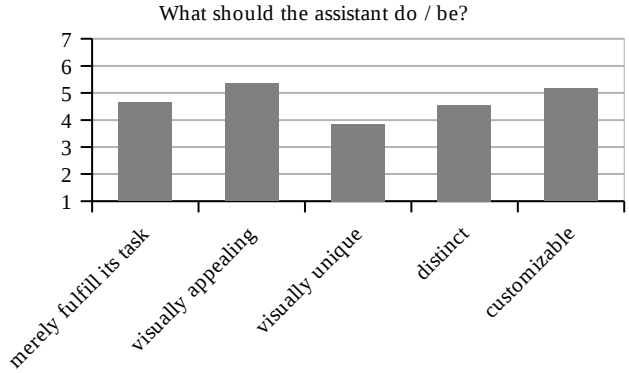

Fig. 1. Means and standard deviations regarding participants' expectations towards a smart home assistant

6 Conclusion and Discussion

Our results show four prominent findings: First, the selection procedure influenced the satisfaction with the virtual agent in the predicted way: Participants were the least satisfied when they had no choice at all, significantly more satisfied when they had the option to choose an agent out of six models, and again more satisfied when they had the option to choose an agent out of 30 models. Above and beyond these effects, there was no increment in satisfaction through self-customization of the virtual agent. Contrary to our predictions, perceived suitability of the virtual agent as a fitness coach was not influenced by the selection procedure. Second, we demonstrated that the relationship between freedom of choice in the selection procedure and satisfaction

with the virtual agent is mediated via the evaluation of the chosen agent in terms of perceived likeability, attractiveness, and competence. Third, asking participants for their general expectations towards a smart home assistant as fitness coach, the central features they indicated are customization, fulfillment of its task, and an appealing visual appearance. Fourth, we found person variables such as gender, age, educational level and prior experience with virtual agents to play a rather minor role. Only perceived task suitability was affected by level of education and prior experience with virtual agents in that persons with a higher level of education and less prior experience rated it more discerningly. Built up on related work from robotics and virtual agents ([7], [9]), our results provide further evidence that involving the user in the selection and customization process increases the satisfaction with the present technical device and is needed to enhance technology acceptance. We mainly ascribe this effect to greater self-investment caused by psychological involvement, which is in line with social psychological theories. As predicted by dissonance theory [11], participants were more satisfied with their choice, when they put more effort in the task. We especially found a strong effect occurring, when participants had to choose one out of six versus one out of 30 agents. This is consistent with our assumption that a greater freedom of choice requires more investment of time and cognitive resources. Notably more investment was needed, when participants had to scan 30 compared to six virtual agents, in order to decide for their preferred one, which resulted in a significantly higher satisfaction with the chosen agent. However, our results show that, when involving persons in the selection procedure, their resulting satisfaction with the virtual agent is mainly driven by likeability, attractiveness, and competence attributed to it. This finding emphasizes the importance to further investigate potential mediators for the relationship between involvement of end users and their attitudes towards the resulting technical devices (cf. [12], [15]).

Limitations and future directions Contrary to our hypotheses, participants who could self-customize their virtual agent were not more satisfied than participants who could choose one out of a set of 30 predefined graphical models. There are two explanations for these unexpected results. Although research shows positive effects of having many choices [10], there is also some evidence for the fact that having too many choices can lead to dissatisfaction and regret [23]. According to Iyengar and Lepper [23] this could be due to an initial disengagement process, which should be tested in future studies. A second explanation might be the fact that participants' actual opportunities to design the virtual agent were still rather restricted, and the stimuli might have not matched the expectations of the participants. The graphical models are for instance not perfect in terms of realistic appearance. Since participants in the self-customization condition had no overview of the generally workable solutions, as they had in the choice conditions, they possibly thought that a better solution existed, but they just were not able to create it. Future studies should investigate an even more advanced setting of participatory design, which might more reliably elicit feelings of accomplishment with the self-designed result. Furthermore, perceived warmth and similarity to oneself had no mediating effect on participants' satisfaction. This could be due to the described role of the virtual agent as fitness coach. We would expect

more influence of these variables for a virtual agent that functions as a social companion. Further studies could shed more light on this.

Recommendations for the design of virtual agents in the smart home context First of all, directly asking people, they clearly request a possibility to customize a virtual assistant for the smart home context. Based on our results, we can recommend giving persons as much freedom as possible in a selection and design procedure for virtual agents. Especially the set ups of Conditions 3 and 4 turn out to be highly recommendable. Second, in line with previous research (e.g. [12,13], [15]), we could show that virtual agents in the smart home context should appear likeable, attractive, and competent. Interestingly, we found a resounding favorite within the pool of virtual agents over all experimental conditions. The female agent no. 10 and no. 7, was chosen noticeably often. This might indicate that besides the wish of customization and freedom of choice, there might exist agents that fit average standards. However, although Conditions 2 to 4 offered the possibility to choose agent no. 10 or no. 7, we still found differences regarding the satisfaction with the resulting agent between those conditions. Finally, we are confident that our research provides a fruitful basis for future research by showing that involvement of the potential end users seems to be the crucial factor in order to maximize user acceptance and to elicit positive attitudes towards virtual agents that serve as smart home assistants.

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