Support From Conversational Agent on Daily Stress for User Satisfaction Improvement

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ABSTRACT

To regulate stress, social sharing is a preferred method. However, people are not always able to find the right person to share their stress experience. In this study, we investigated the support from conversational agent (CA) for the users who encounter with daily stress to help them get socio-emotional benefits and therefore improve the user satisfaction. We developed a 2 (CA gender) $\times$ 3 (type of support) between-subject experiment via the Wizard-of-Oz method. The results showed that CA should have stress support function, even stressor detection and support function, and should be designed preferentially as female voice. The influence mechanism showed that the independent variables (CA gender and support type) influenced satisfaction through the mediator variable: social presence and favourability. This study provides guidance for the design of CA for stress support, and the findings provide a reference basis for the design of speech interaction between CA and users.

Keywords: Conversational agent, Daily stress, User satisfaction

INTRODUCTION

Daily stress is a universally experienced phenomenon in our modern lives (Piazza et al., 2013). Daily stress is the strain caused by challenges of day-to-day living (Piazza et al., 2013). Studies have shown that cumulative stress in daily life can result in cardiovascular disease (Schubert et al., 2009) and psychological or behavioral disorders, such as depression and anxiety (Cohen et al., 1997).

To regulate stress, social sharing is often used as a method. By talking to others, sharers can gain support that help them cope with their stress events (Rimé, 2009). However, people are not always comfortable sharing their stress events with others, such as the stigmatised issues (Major & O'Brien, 2005). In addition, people are not always able to find the right person to talk to. Their friends may be tired of hearing about the same issues (Forest et al., 2014). Besides, professional help may be too expensive and require long waits (Hunt & Eisenberg, 2010).

With the development of conversational agent (CA), the CA should provide support for the users who encounter with daily stress to help them get socio-emotional benefits and therefore improve the user satisfaction (Pauw et al., 2022). Researches have focused on how CA provide support for users who were under negative emotion (Bendig et al., 2022; Pauw et al., 2022). Similarly, CA should provide supportive responses to users facing daily stress for timely stress relief.

Compared with traditional CA without stress detection and support function, it should be examined whether CA with stress detection and support function can help to enhance users' interaction experience under daily stress. In addition, the response content of CA with support function should be further investigated. Based on the general supportive responses, whether targeted responses with stressors have a positive impact on enhancing user experience. Therefore, this study focused on three support types of CA: without stress support function, with stress detection and support function, with stressor detection and stressor-based targeted support function.

At the same time, the gender of CA should be considered as a factor which influence the user satisfaction of daily stress support. Relevant studies have shown that CA gender had an impact on user likeability and satisfaction (Seaborn et al., 2022). Some studies have shown that robots with feminine voices (Chang et al., 2018) were the most liked and favoured. However, there were findings that male synthesised voices were more popular and persuasive than female synthesised voices (Mullennix et al., 2003). Besides, some studies suggested that voices the same with the gender of the user were more favoured (Seaborn et al., 2022). However, the voice gender preference of users during speech interaction with CA under daily stress was still not clear.

In summary, this study investigated the effects of CA gender and support type on user satisfaction. Based on the findings, this study will optimise the interaction capabilities of CA, thereby enhancing user satisfaction and expanding the timely accessibility of stress relief manner for users in their daily lives.

METHODS

In this study, we developed a 2 (CA genders) × 3 (types of support) between-subject experiment on user satisfaction of CA. The CA had two types of gender, including male and female. Three support types included control (without stress support function), stress (with stress detection and support function), and stressor (with stressor detection function, and support targeted at stressor) groups. So, there were six types of CA in this experiment.

Participants

In addition to the participants who were excluded due to equipment problems, a total of 76 participants (38 males and 38 females) were retained for this experiment. The mean age of participants was 23.7 years, with standard deviation of 3.6 years. The basic information of the participants is shown in Table 1.

Table 1. Basic information of participants.

Participants		Groups					
		Female CA			Male CA		
		Control	Stress	Stressor	Control	Stress	Stressor
Number	Male	6	7	6	6	7	6
	Female	6	7	6	6	7	6
Age	Mean	25.3	24.1	23.1	21.8	23.8	23.9
	SD	3.7	3.3	4.1	2.3	4.1	3.4

Procedure

The flow of the experiment is shown in Figure 1. All participants signed an informed consent upon arrival at the experimental site. Afterwards, a pre-experiment personal information questionnaire was filled out. During the experiment, participants were asked to communicate and share one personal daily stress experience event with a CA, which was assigned from the six CAs randomly and provided support via the Wizard-of-Oz method (a human-operated CA). After the communication, participants were invited to evaluate the CA. The experimental protocol was reviewed by the Institutional Review Board (IRB) committee of the Institute of Human Factors and Human-System Interaction.
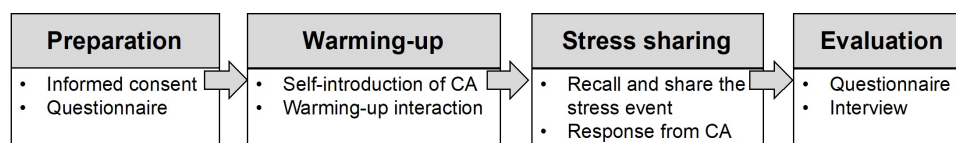
Figure 1: Procedure of experiment.

Dependent Variable

In this study, the dependent variable of subjective evaluation is user satisfaction. Meanwhile, we analysed the mediator variables, including: social presence, perceived personalisation, favourability, and trust. All variables in this study were measured using 7-point Likert scales.

These mediator variables were selected according to the previous findings as follows:

- According to the reciprocity model of social perception, social presence can enhance reciprocal behaviours in human-intelligent agent interactions, and therefore facilitate the formation of intimate relationships and improve user satisfaction (Kühne & Peter, 2023).
- Perceived personalisation can contribute to service satisfaction and users' perception of intimacy (Verhagen et al., 2014).
- Recent studies have confirmed the importance of favourability and its influence on the enhancement of user-agent relationships and user satisfaction (Ashktorab et al., 2020).

- According to the studies of users' feelings toward agents, trust can enhance the user satisfaction, leading to desired user behaviors (Lee & Yi, 2023).

RESULTS

The results of subjective evaluation were shown in Table 2, with the coefficient of reliability (Cronbach's α) of each scale used in this experiment.

Table 2. Subjective evaluation results and the Cronbach's α of each scale.

Groups	Female CA						Male CA						α
	Control		Stress		Stressor		Control		Stress		Stressor		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Social presence	2.32	1.03	4.24	0.81	4.28	0.97	1.72	0.79	3.40	0.96	3.87	1.01	0.90
Perceived personalisation	2.25	0.81	4.33	0.74	4.33	1.01	1.64	0.59	3.64	0.86	4.03	0.95	0.84
Favourability	2.99	0.97	4.81	0.55	4.58	1.26	2.00	0.69	4.29	0.88	4.36	0.88	0.96
Trust	4.32	0.88	5.64	0.52	5.53	0.85	3.60	1.01	5.46	0.86	5.67	0.67	0.91
Satisfaction	2.31	1.12	4.82	0.76	4.81	1.38	1.85	0.91	4.00	1.34	4.10	1.07	0.96

ANOVA Analysis

This experiment explored the effect of CA gender and support type on user satisfaction through Two-Way ANOVA (see Table 3). In addition, this experiment used Bonferroni adjustment for post hoc multiple comparisons (see Figure 2).

Table 3. ANOVA analysis results of subjective evaluation.

| Variable	Factor	F	p	η^2
Social presence	Support type	35.489	<0.001***	0.472
	Gender	8.750	0.004**	0.058
	Support type × Gender	0.344	0.710	0.005
Perceived personalisation	Support type	53.924	<0.001***	0.578
	Gender	8.065	0.006**	0.043
	Support type × Gender	0.372	0.691	0.004
Favourability	Support type	42.258	<0.001***	0.513
	Gender	7.896	0.006**	0.048
	Support type × Gender	1.138	0.326	0.014
Trust	Support type	32.909	<0.001***	0.466
	Gender	1.823	0.181	0.013
	Support type × Gender	1.751	0.181	0.025
Satisfaction	Support type	36.235	<0.001***	0.484
	Gender	6.839	0.011*	0.046
	Support type × Gender	0.175	0.840	0.002
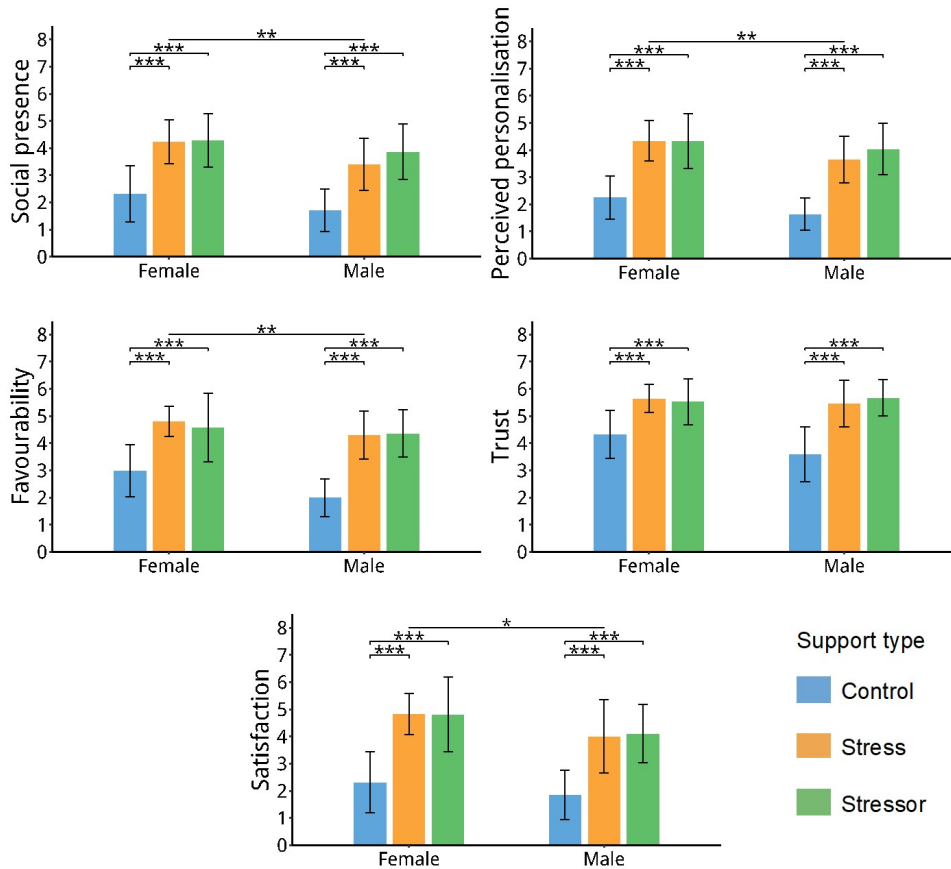
Figure 2: ANOVA and post hoc analysis of subjective evaluation.

The results of the Two-Way ANOVA showed that there was no interaction effect between CA gender and support type on any of the five dimensions of subjective evaluation.

The main effects of support type were significant on social presence $(F(2,70) = 35.489, p < 0.001, \eta^2 = 0.472)$, perceived personalisation $(F(2,70) = 53.924, p < 0.001, \eta^2 = 0.578)$, favourability $(F(2,70) = 42.258, p < 0.001, \eta^2 = 0.513)$, trust $(F(2,70) = 32.909, p < 0.001, \eta^2 = 0.466)$, and satisfaction $(F(2,70) = 36.235, p < 0.001, \eta^2 = 0.484)$.

Post hoc tests showed that the control group's social presence (M = 2.02, SD = 0.95), perceived personalisation (M = 1.94, SD = 0.76), favourability (M = 2.50, SD = 0.97), trust (M = 3.96, SD = 1.00), satisfaction (M = 2.08, SD = 1.03) were significantly lower than those of the stress group's social presence (M = 3.82, SD = 0.97, p<0.001), perceived personalisation (M = 3.99, SD = 0.86, p<0.001), favourability (M = 4.55, SD = 0.77, p<0.001), trust (M = 5.55, SD = 0.70, p<0.001), satisfaction (M = 4.41, SD = 1.15, p<0.001) and the stressor group's social presence (M = 4.08, SD = 0.99, p<0.001), perceived personalisation (M = 4.18, SD = 0.97, p<0.001), favourability (M = 4.47, SD = 1.07, p<0.001), trust (M = 5.60, SD = 0.75, p<0.001), satisfaction (M = 4.46, SD = 1.26, p<0.001).

CA gender had significant main effects on social presence ($F(1,70) = 8.750$, $p = 0.004$, $\eta^2 = 0.058$), perceived personalisation ($F(1,70) = 8.065$, $p = 0.006$, $\eta^2 = 0.043$), favourability ($F(1,70) = 7.896$, $p = 0.006$, $\eta^2 = 0.048$), and satisfaction ($F(1,70) = 6.839$, $p = 0.011$, $\eta^2 = 0.046$). The female CA had significantly higher social presence ($M = 3.65$, $SD = 1.29$), perceived personalisation ($M = 3.68$, $SD = 1.28$), favourability ($M = 4.16$, $SD = 1.23$), and satisfaction ($M = 4.03$, $SD = 1.59$) than the male CA's social presence ($M = 3.02$, $SD = 1.28$, $p = 0.004$), perceived personalisation ($M = 3.13$, $SD = 1.31$, $p = 0.006$), favourability ($M = 3.59$, $SD = 1.36$, $p = 0.006$), and satisfaction ($M = 3.36$, $SD = 1.52$, $p = 0.011$). Whereas CA gender had no significant effect on the evaluation of trust.

Mediation Analysis

In order to investigate the mechanism of user satisfaction evaluation, we used the parallel mediated effects to analyse how the gender and support type of CA influence user satisfaction by social presence, perceived personalisation, favourability, and trust (see Table 4).

Table 4. Mediation analysis results.

| Item	c	a	b	a*b	c'	Result
Support type => Social presence => Satisfaction	1.188**	1.029**	0.270*	0.278**	0.104	Full mediation
Support type => Perceived personalisation=> Satisfaction	1.188**	1.118**	0.207	0.232**	0.104	No significant mediation
Support type => Favourability => Satisfaction	1.188**	0.988**	0.705**	0.696**	0.104	Full mediation
Support type => Trust => Satisfaction	1.188**	0.819**	-0.148	-0.122	0.104	No significant mediation
Gender => Social presence => Satisfaction	-0.671*	-0.632**	0.270*	-0.170	-0.021	Full mediation
Gender => Perceived personalisation=> Satisfaction	-0.671*	-0.544*	0.207	-0.113	-0.021	No significant mediation
Gender => Favourability => Satisfaction	-0.671*	-0.574*	0.705**	-0.404	-0.021	Full mediation
Gender => Trust => Satisfaction	-0.671*	-0.250	-0.148	0.037	-0.021	No significant mediation

Note: * $p<0.05$; ** $p<0.01$. c': Direct effect; a*b: Indirect effect; c: Total effect

The mediation effect analysis showed that the direct effect of support type on user satisfaction was not significant (direct effect c' was not significant). The support type had significant effects on the social presence, perceived personalisation, favourability, and trust (effect 'a' was significant). Meanwhile, the social presence and favourability had significant effects on user satisfaction (effect 'b' was significant). Therefore, the support type of CA had a

significant positive effect on user satisfaction through the mediator variables (social presence and favourability) with full mediation. The higher support type (in the order of control group, stress group, and stressor group) led to the higher social presence and favourability, which in turn led to the higher user satisfaction.

The direct effect of CA gender on user satisfaction was not significant (direct effect c' was not significant). However, CA gender had significant effects on the social presence, perceived personalisation, and favourability (effect 'a' was significant). Meanwhile, the social presence and favourability had significant effects on user satisfaction (effect 'b' was significant). Therefore, CA gender had a significant negative effect (fully mediated) on user satisfaction through the mediators (social presence and favourability). Compared to male CA, the female CA resulted in higher social presence and favourability, and therefore led to higher user satisfaction.

Based on the results of the mediation effect analysis, the paths with significant results are summarised in the mediation model with solid arrows (see Figure 3). Female CA obtained higher user satisfaction than male CA. Meanwhile, the higher support type achieved the higher user satisfaction. Both the gender and the support type of CA affected user satisfaction through the mediators: social presence and favourability.
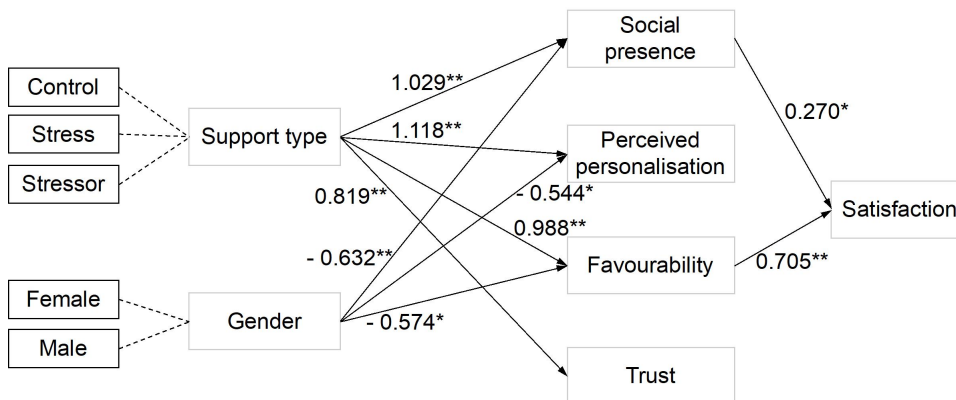
Figure 3: Summary of mediation analysis results.

DISCUSSION

According to participants' subjective evaluations, users were more satisfied of female CA with stress or stressor support function. With respect to the gender of CA, participants were more satisfied with female CA. The female CA achieved higher social presence, perceived personalisation, and favourability. This finding is consistent with previous results in the literature. The female voice (Chang et al., 2018) and higher-pitched voice (Niculescu et al., 2011) are more preferred. Female voice is rated by users as more pleasant (Bazilinskyy & De Winter, 2015) and easier to understand (Bazilinskyy & De Winter, 2017). Regarding the support type of CA, participants rated higher satisfaction for CA with stress or stressor support function than CA

without stress support function. The subjective evaluation of participants showed that the social presence, perceived personalisation, favourability, trust, and satisfaction of stress group and stressor group were significantly higher than that of control group. While, these variables of stressor group had no significant difference with that of stress group. This result is consistent with related findings from previous research that increasing the affective responses of CA can increase usage intention and satisfaction of users (Hong et al., 2017).

In order to investigate the influence mechanism of CA gender and support type on user satisfaction, this study conducted mediation effect analysis with the mediator variables of social presence, perceived personalisation, favourability, and trust. The results showed that CA gender negatively affected user satisfaction through the social presence and favourability (female CA obtained higher user satisfaction than male CA), which was related to the fact that female voice was more preferred than male voice (Chang et al., 2018). Meanwhile, CA's support type positively influenced user satisfaction through social presence and favourability (the higher stress and stressor support type obtained the higher user satisfaction). In addition, neither of the two independent variables of CA had an effect on user satisfaction through perceived personalisation and trust. Therefore, perceived personalisation and trust might not be the main path through which the CA independent variables influenced user satisfaction in this study.

According to the interview after the experiment, the participants in the stressor group proposed more requirements for the targeted advice from CA. They explained that they felt the high intelligent level of the CA. So, they were looking forward for the help from the CA for the solution of their daily stress events.

CONCLUSION

According to the results of this study, the support for daily stress from CA can improve the user satisfaction. Between different genders of CA, the female CA is more preferred in this study. What's more, the influence mechanism shows that the CA gender and support type influence user satisfaction through the mediator variables: social presence and favourability. This study provides guidance for the design of stress support of CA. The related findings provide a reference basis for the design of interaction manner between CA and users.

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REFERENCES

Ashktorab, Z., Liao, Q. V., Dugan, C., Johnson, J., Pan, Q., Zhang, W., Kumaravel, S., & Campbell, M. (2020). Human-AI Collaboration in a Cooperative Game Setting: Measuring Social Perception and Outcomes. Proceedings of the

ACM on Human-Computer Interaction, 4(CSCW2), 1–20. https://doi.org/10.1145/3415167

Bazilinskyy, P., & De Winter, J. (2015). Auditory interfaces in automated driving: An international survey. PeerJ Computer Science, 1, e13. https://doi.org/10.7717/peerj-cs.13

Bazilinskyy, P., & De Winter, J. C. F. (2017). Analyzing crowdsourced ratings of speech-based take-over requests for automated driving. Applied Ergonomics, 64, 56–64. https://doi.org/10.1016/j.apergo.2017.05.001

Bendig, E., Erb, B., Schulze-Thuesing, L., & Baumeister, H. (2022). The Next Generation: Chatbots in Clinical Psychology and Psychotherapy to Foster Mental Health – A Scoping Review. Verhaltenstherapie, 32(Suppl. 1), 64–76. https://doi.org/10.1159/000501812

Chang, R. C.-S., Lu, H.-P., & Yang, P. (2018). Stereotypes or golden rules? Exploring likable voice traits of social robots as active aging companions for tech-savvy baby boomers in Taiwan. Computers in Human Behavior, 84, 194–210. https://doi.org/10.1016/j.chb.2018.02.025

Cohen, S., Kessler, R. C., & Gordon, L. U. (1997). Measuring stress: A guide for health and social scientists. Oxford University Press on Demand.

Forest, A. L., Kille, D. R., Wood, J. V., & Holmes, J. G. (2014). Discount and disengage: How chronic negative expressivity undermines partner responsiveness to negative disclosures. Journal of Personality and Social Psychology, 107(6), 1013–1032. https://doi.org/10.1037/a0038163

Hong, E., Cho, K., & Choi, J. (2017). Effects of Anthropomorphic Conversational Interface for Smart Home: An Experimental Study on the Voice and Chatting Interactions. Journal of the HCI Society of Korea, 12(1), 15. https://doi.org/10.17210/jhsk.2017.02.12.1.15

Hunt, J., & Eisenberg, D. (2010). Mental Health Problems and Help-Seeking Behavior Among College Students. Journal of Adolescent Health, 46(1), 3–10. https://doi.org/10.1016/j.jadohealth.2009.08.008

Kühne, R., & Peter, J. (2023). Anthropomorphism in human–robot interactions: A multidimensional conceptualization. Communication Theory, 33(1), 42–52. https://doi.org/10.1093/ct/qtac020

Lee, B., & Yong Yi, M. (2023). Understanding the Empathetic Reactivity of Conversational Agents: Measure Development and Validation. International Journal of Human–Computer Interaction, 1–19. https://doi.org/10.1080/10447318.2023.2270665

Major, B., & O'Brien, L. T. (2005). The Social Psychology of Stigma. Annual Review of Psychology, 56(1), 393–421. https://doi.org/10.1146/annurev.psych.56.091103.070137

Mullennix, J. W., Stern, S. E., Wilson, S. J., & Dyson, C. (2003). Social perception of male and female computer synthesized speech. Computers in Human Behavior, 19(4), 407–424. https://doi.org/10.1016/S0747-5632(02)00081-X

Niculescu, A., Van Dijk, B., Nijholt, A., & See, S. L. (2011). The influence of voice pitch on the evaluation of a social robot receptionist. 2011 International Conference on User Science and Engineering (i-USEr), 18–23. https://doi.org/10.1109/iUSEr.2011.6150529

Pauw, L. S., Sauter, D. A., Van Kleef, G. A., Lucas, G. M., Gratch, J., & Fischer, A. H. (2022). The avatar will see you now: Support from a virtual human provides socio-emotional benefits. Computers in Human Behavior, 136, 107368. https://doi.org/10.1016/j.chb.2022.107368

Piazza, J. R., Charles, S. T., Sliwinski, M. J., Mogle, J., & Almeida, D. M. (2013). Affective Reactivity to Daily Stressors and Long-Term Risk of Reporting a Chronic Physical Health Condition. Annals of Behavioral Medicine, 45(1), 110–120. https://doi.org/10.1007/s12160-012-9423-0

Rimé, B. (2009). Emotion Elicits the Social Sharing of Emotion: Theory and Empirical Review. Emotion Review, 1(1), 60–85. https://doi.org/10.1177/1754073908097189

Schubert, C., Lambertz, M., Nelesen, R. A., & Bardwell, W. (2009). Effects of stress on heart rate complexity—A comparison between short-term and chronic stress. Biological Psychology, 8.

Seaborn, K., Miyake, N. P., Pennefather, P., & Otake-Matsuura, M. (2022). Voice in Human–Agent Interaction: A Survey. ACM Computing Surveys, 54(4), 1–43. https://doi.org/10.1145/3386867

Verhagen, T., Van Nes, J., Feldberg, F., & Van Dolen, W. (2014). Virtual Customer Service Agents: Using Social Presence and Personalization to Shape Online Service Encounters. Journal of Computer-Mediated Communication, 19(3), 529–545. https://doi.org/10.1111/jcc4.12066