Conversational Agents for Health and Wellbeing: Review and Future Agendas

Junhan Kim
University of Michigan
Ann Arbor, MI 48109, USA
ericjhk@umich.edu

Sun Young Park
University of Michigan
Ann Arbor, MI 48109, USA
sunypark@umich.edu

Lionel Robert
University of Michigan
Ann Arbor, MI 48109, USA
lprobert@umich.edu

Abstract
This paper is a literature review of 57 papers that have examined the role and impact of conversational agents (CAs) in the health domain. We note that three key themes repeatedly arose during the review: therapeutic alliance, trust, and human intervention. We also point out several areas that have been largely overlooked, such as specific patient characteristics that influenzce the effects of CA usage, the results of differing CA designs, and specific human-CA relationships. Based on the current gaps in scholarship, we recommend several future intersections at which CAs and healthcare can meet.

CSCW 2019 Extended Abstracts, November 9-13, Austin, TX, USA.

ACM ISBN 978-1-4503-6819-3/20/04.

Author Keywords
Artificial intelligence; conversational agent; healthcare; virtual agent; wellbeing.

CSS Concepts
• Human-centered computing~Human computer interaction (HCI)

Introduction
Advances in artificial intelligence (AI) technology have brought heightened attention to conversational agents (CAs, popularly referred to as chatbots) in industry and academia. The terms chatbots and CA are often used interchangeably, as both refer to systems that mimic human language and behavior to implement certain tasks for the user via a chat interface, either text-based or voice-based [1]. Technological giants (e.g., Google, Amazon, and Apple) have commercialized such CAs in forms of both hardware (Amazon Echo or Google

Home) and software (such as Apple Siri) [17,3,4]. CAs are now widely used across many fields, such as museum tours [22], tourism activities [30], various learning environments [3], and mental health interventions [13].

The healthcare field has enthusiastically embraced the use of CAs as a patient care aid to support physical/mental health, by serving as an e-health tool that is convenient, easy to use, and allows patients to overcome health literacy barriers [19, 35]. For instance, Bickmore et al. [6] explain how CAs can be utilized to establish a therapeutic alliance, which improves the quality of the relationship between the health care provider and the patient [5]. A therapeutic alliance has been established as a key factor in successful interventions in the mental health domain [28, 32]. CAs are useful in establishing this alliance as patients have been shown to be more willing to self-disclose personal information to virtual therapists compared to actual human therapists [25] because they felt that their responses were not being judged.

However, although the adoption of CAs into the health and wellbeing field seems positive, it represents a relatively new advancement in treatment options, with many factors yet to be explored. The relatively large amount of publications appearing in the engineering or the medical domain [37] presents an opportunity for HCI professionals to bridge multiple stakeholders by designing user-centered tools for patients. Therefore, we decided to complete a review of past literature featuring CAs and healthcare to discover which areas should be focused on by HCI professionals.

We conducted a literature review of 57 papers selected from the ACM Digital Library, AMIA, JMIR, and Google Scholar. We deduced several salient themes from this literature review and were also able to isolate and recommend several future research topics. From our research, three important themes emerged that pertained to CAs: therapeutic alliance, trust, and human intervention. Secondly, we discovered that specific patient characteristics, the effects of different CA designs, and human-CA relationships have been largely overlooked. Finally, we provide recommendations for future research to design and incorporate CAs that can meet various healthcare demands, such as patient characterization, establishing children as a target group, and evaluating different CA designs.

Literature Selection and Analysis

Papers were selected from the ACM Digital Library, AMIA, JMIR, and Google Scholar based on queries such as "artificial intelligence," "conversational agents," and "healthcare." We excluded papers that were heavily focused on algorithm development due to our primary interest being in HCI and CSCW. In this paper, we do not intend to provide a complete scope of all existing literature, but rather to focus on providing critical insights that will contribute to an informed discussion during the workshop. The papers were analyzed with a focus on CA features. We divided the features of each CA into four categories: modality, level of analysis, therapy content, and user benefits. Each category contains corresponding sub-categories, such as text/voice, mobile/tablet for modality, or therapeutic alliance/trust/customization for user benefits. Finally, we measured the sub-categories that appeared frequently.

Past Literature on CA and Healthcare

We have identified three key themes that feature predominantly in prior literature: therapeutic alliance, trust, and human intervention. First, an examination of the therapeutic alliance between CAs and patients was included in 14/57 (25%) papers. Since CAs can listen to patients and give them feedback, they are able to form a therapeutic alliance with patients. Studies show that therapeutic alliance is important because it is positively correlated with satisfaction towards the system, patients' desire to continue using the service, and expectation to follow the CA's advice [7]. This was enhanced by the CAs offering effective support or displays of empathy, either directly [7] or indirectly [7,18,40,26]. CAs can develop rapport with the patient, generating the perception of therapeutic alliance [11]. To this end, several works have embedded empathetic responses into their CAs, both verbally and nonverbally [2,7,8,16]. A recent publication demonstrated how not only *being cared by a CA*, but *caring for a CA* results in more positive outcomes in terms of self-compassion [24].

The next important factor for clinical CAs is trust. This feature was addressed in 7/57 (12%) papers. The level of trust the user felt towards the CA is an important foundation in shaping willingness to interact with them [38, 39]. Xu established that trust in a system with a robotic agent is not different from trust with a human agent [41]. Kang and Wei demonstrated that when a patient's support needs – whether informational or emotional – align with the CA's responses, trust towards them increases [20]. Zhang et al. showed that a patient's trust increases when the provider's interest aligns with that of the patient [42]. Fadhil et al. demonstrated that there is an interaction effect between communication style (including emoji or text only) and topic of dialogue (physical well-being or mental well-being), which impacts trust in the CA [15]. As such, through different conversational or visual designs, researchers have tried to increase the level of trust users feel towards the CAs.

Finally, the last factor of CA is human intervention. This feature appeared in 6 out of the 57 papers. Studies often included intervention by human therapists because CA technology does not aim to replace human healthcare professionals [27] and is not yet capable of being highly responsive and empathetic [23]. Human therapist exists to address situations beyond the capabilities of CAs [34]. Specific circumstances where a human therapist is called for include asthma [34], suicidal behavior [29], hospital discharge with patients with depressive symptoms [7] or diabetes [8]. It would be useful to develop a tool that calculates when a human therapist should intervene. Methods such as cloud computing [12], data log [9], and feature integration [14], could be used to conduct future research that contextualizes patient settings and determine if and when human intervention is necessary.

Gaps in Prior Work and Future Work

Across the three salient themes on which CA research has been primarily focused, we have found three possible avenues for future research that have not been sufficiently addressed. First, the characteristics of target patients have been neglected. Many studies have focused on the clinical outcomes of patients without addressing individual differences among patient groups. Moreover, the designs of CAs have not been varied sufficiently to test the validity of CA intervention. Most

studies have utilized a single CA design decision, without evaluating which design is more suitable for a certain target group or certain health problem. Lastly, the relationship between the CA and human should be investigated further. Given the advent of AI-based CAs, we believe there has been insufficient research on identifying and evaluating factors that contribute to alliance and trust between AI-based CAs and humans in the health domain, and how human therapists and CAs can collaborate for clinical goals.

Based on the identified unexplored areas, we provide recommendations for future research. First, we recommend identifying patient characteristics and applying them to the CA intervention. This is important because characterizing the user allows the system to customize the intervention to best meet patient needs. Customization of AI technology and CAs is an important aspect for user satisfaction and adherence [10, 18, 34], and research that distinguishes user characteristics and applies them to CA development is necessary (e.g., how do patients with different loci of control benefit from different sets of motivational messages).

Second, we recommend studying children as a target group. Children's fascination for technology [33], inclination to disclose personal information to virtual agents [31], and robots such as Paro [36] indicate that there is great potential for CAs to be specifically targeted towards children. With the advent of more natural synthetic voice technology, we expect that children will be able to easily access CAs without assistance. However, ethical issues must be considered to ensure children's safety and privacy.

Finally, we recommend trialing different CA designs to deliver interventions and build alliances or trust. For example, what modalities are especially important for the treatment of patients with autism? Various platforms such as mobile or at home CAs (e.g., Amazon Echo), can also be tested. What are the different effects that arise from this distinction? How can different CA designs induce therapeutic alliances or trust?

Expectations for the Workshop

We would appreciate the opportunity to participate in this workshop for CSCW 2019 because of the relevance to our research and the fruitful discussions it will hold. The first author's previous work on CAs and healthcare was based on a workshop and interviews with teenagers which sought to understand how teenagers would like CAs to be designed for stress management [21]. The study showed that teenagers want to talk to CAs because they believe CAs can keep their secrets, provide them with useful information, and are available 24/7. However, it failed to see CA as a collaborative tool, focusing on user-centered design, not a social point of view. The workshop's theme surrounding the social aspects of AI such as its role, trust and collaboration with humans will help us broaden our perspective and conduct future research in a different point of view. We also hope to hear the opinions about our research questions and directions we will bring to the workshop. It will be a valuable experience to listen to the insights of other medical and connect with them.

We can contribute to the workshop by bringing a new perspective from UX viewpoint and providing background for the discussion gained through our literature review. We hope to share the lessons learned from our experience for a productive workshop.

References

1. Sameera Abdul-Kader and J. C. Woods. 2015. Survey on chatbot design techniques in speech conversation systems. *International Journal of Advanced Computer Science and Applications* 6, no. 7. DOI: https://doi.org/10.14569/IJACSA.2015.060712
2. Glenn Albright, Cyrille Adam, Deborah Serri, Seth Bleeker, and Ron Goldman. 2016. Harnessing the power of conversations with virtual humans to change health behaviors. *Mhealth* 2. DOI: https://doi.org/10.21037/mhealth.2016.11.02
3. Amazon Echo. Retrieved October 14, 2019 from https://www.amazon.com/all-new-amazon-echo-speaker-with-wifi-alexa-dark-charcoal/dp/B06XCM9LJ4
4. Apple Siri. Retrieved October 14, 2019 from https://www.apple.com/kr/siri/
5. Katherine Berry, Amy Salter, Rohan Morris, Susannah James, and Sandra Bucci. 2018. Assessing therapeutic alliance in the context of mHealth interventions for mental health problems: development of the mobile Agnew relationship measure (mARM) questionnaire. *Journal of medical Internet research* 20, no. 4: e90. DOI: https://doi.org/10.2196/jmir.8252
6. Timothy W. Bickmore, Amanda Gruber, and Rosalind Picard. 2005. Establishing the computer–patient working alliance in automated health behavior change interventions. *Patient education and counseling* 59, no. 1: 21-30. DOI: https://doi.org/10.1016/j.pec.2004.09.008
7. Timothy W. Bickmore, Suzanne E. Mitchell, Brian W. Jack, Michael K. Paasche-Orlow, Laura M. Pfeifer, and Julie O'Donnell. 2010. Response to a relational agent by hospital patients with depressive symptoms. *Interacting with computers* 22, no. 4 2010: 289-298. DOI: https://doi.org/10.1016/j.intcom.2009.12.001
8. Timonthy W. Bickmore, Rebecca A. Silliman, Kerrie Nelson, Debbie M. Cheng, Michael Winter, Lori Henault, and Michael K. Paasche-Orlow. 2013. A randomized controlled trial of an automated exercise coach for older adults. *Journal of the American Geriatrics Society* 61, no. 10: 1676-1683. DOI: https://doi.org/10.1111/jgs.12449
9. Lesley-Ann Black, Michael McTear, Norman D. Black, Roy Harper, and Michelle Lemon. 2005. Appraisal of a conversational artefact and its utility in remote patient monitoring." In *18th IEEE Symposium on Computer-Based Medical Systems (CBMS'05)*, 506-508. DOI: https://doi.org/10.1109/CBMS.2005.33
10. Christopher Burton, Aurora Szentagotai Tatar, Brian McKinstry, Colin Matheson, Silviu Matu, Ramona Moldovan, Michele Macnab et al. 2016. Pilot randomised controlled trial of Help4Mood, an embodied virtual agent-based system to support treatment of depression. *Journal of telemedicine and telecare* 22, no. 6: 348-355. DOI: https://doi.org/10.1177/1357633X15609793
11. Gillian C. Cameron, David Cameron, Gavin Megaw, R. R. Bond, Maurice Mulvenna, Siobhan O'Neill, Cherie Armour, and Michael McTear. 2018. Best practices for designing chatbots in mental healthcare–A case study on iHelpr. In *British HCI Conference 2018*. DOI: http://dx.doi.org/10.14236/ewic/HCI2018.129
12. Kyungyong Chung, and Roy C. Park. 2019. Chatbot-based heathcare service with a knowledge base for cloud computing. *Cluster Computing* 22, no. 1: 1925-1937. DOI: https://doi.org/10.1007/s10586-018-2334-5
13. Mauro Dragone, Thomas Holz, Brian R. Duffy, and Greogory MP O'Hare. 2005. Social situated agents in virtual, real and mixed reality environments. In *International Workshop on Intelligent Virtual Agents*, pp. 166-177. Springer, Berlin, Heidelberg. DOI: https://doi.org/10.1007/11550617_15

14. Ahmed Fadhil and Silvia Gabrielli. 2017. Addressing challenges in promoting healthy lifestyles: the al-chatbot approach. In *Proceedings of the 11th EAI International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth '17)*. ACM, New York, NY, USA, 261-265. DOI: https://doi.org/10.1145/3154862.3154914

15. Ahmed Fadhil, Gianluca Schiavo, Yunlong Wang, and Bereket A. Yilma. 2018. The Effect of Emojis when interacting with Conversational Interface Assisted Health Coaching System. In *Proceedings of the 12th EAI International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth '18)*. ACM, New York, NY, USA, 378-383. DOI: https://doi.org/10.1145/3240925.3240965

16. Kathleen K. Fitzpatrick, Alison Darcy, and Molly Vierhile. 2017. Delivering cognitive behavior therapy to young adults with symptoms of depression and anxiety using a fully automated conversational agent (Woebot): a randomized controlled trial. *JMIR mental health* 4, no. 2: e19. DOI: https://doi.org/10.2196/mental.7785

17. Google Home. Retrieved October 14, 2019 from https://store.google.com/us/product/google_home

18. Eva Hudlicka. 2013. Virtual training and coaching of health behavior: Example from mindfulness meditation training. *Patient education and counseling* 92, no. 2: 160-166. https://doi.org/10.1016/j.pec.2013.05.007

19. Takeshi Kamita, Takeshi, Tatsuya Ito, Atsuko Matsumoto, Tsunetsugu Munakata, and Tomoo Inoue. 2019. A Chatbot System for Mental Healthcare Based on SAT Counseling Method. *Mobile Information Systems* 2019. DOI: https://doi.org/10.1155/2019/9517321

20. Jin Kang and Lewen Wei. 2018. "Give Me the Support I Want!": The Effect of Matching an Embodied Conversational Agent's Social Support to Users' Social Support Needs in Fostering Positive User-Agent Interaction. In *Proceedings of the 6th International Conference on Human-Agent Interaction (HAI '18)*. ACM, New York, NY, USA, 106-113. DOI: https://doi.org/10.1145/3284432.3284462

21. Junhan Kim, Yoojung Kim, Byungjoon Kim, Sukyung Yun, Minjoon Kim, and Joongseek Lee. 2018. Can a Machine Tend to Teenagers' Emotional Needs?: A Study with Conversational Agents. In Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (CHI EA '18). ACM, New York, NY, USA, Paper LBW018, 6 pages. DOI: https://doi.org/10.1145/3170427.3188548

22. Stefan Kopp, Lars Gesellensetter, Nicole C. Krämer, and Ipke Wachsmuth. "A conversational agent as museum guide–design and evaluation of a real-world application." In *International Workshop on Intelligent Virtual Agents*, pp. 329-343. Springer, Berlin, Heidelberg, 2005. DOI: https://doi.org/10.1007/11550617_28

23. Kira Kretzschmar, Holly Tyroll, Gabriela Pavarini, Arianna Manzini, Ilina Singh, and NeurOx Young People's Advisory Group. 2019. Can your phone be your therapist? Young people's ethical perspectives on the use of fully automated conversational agents (Chatbots) in mental health support." *Biomedical informatics insights* 11. DOI: https://doi.org/10.1177/1178222619829083.

24. Minha Lee, Sander Ackermans, Nena van As, Hanwen Chang, Enzo Lucas, and Wijnand IJsselsteijn. 2019. Caring for Vincent: A Chatbot for Self-Compassion. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, p. 702. ACM. DOI: https://doi.org/10.1145/3290605.3300932

25. Gale M. Lucas, Jonathan Gratch, Aisha King, and Louis-Philippe Morency. 2014. It's only a computer: Virtual humans increase willingness to

disclose. *Computers in Human Behavior* 37: 94-100. DOI: http://dx.doi.org/10.1016/j.chb.2014.04.043

26. Gale M. Lucas, Nicole Krämer, Clara Peters, Lisa-Sophie Taesch, Johnathan Mell, and Jonathan Gratch. 2018. Effects of Perceived Agency and Message Tone in Responding to a Virtual Personal Trainer. In *Proceedings of the 18th International Conference on Intelligent Virtual Agents*, 247-254. ACM. DOI: https://doi.org/10.1145/3267851.3267855
27. David D. Luxton. 2015. *Artificial intelligence in behavioral and mental health care*. Academic Press.
28. Daniel J. Martin, John P. Garske, and M. Katherine Davis. 2000. Relation of the therapeutic alliance with outcome and other variables: a meta-analytic review. *Journal of consulting and clinical psychology* 68, no. 3: 438. DOI: http://dx.doi.org/10.1037/0022-006X.68.3.438
29. Adam S. Miner, Arnold Milstein, Stephen Schueller, Roshini Hegde, Christina Mangurian, and Eleni Linos. 2016. Smartphone-based conversational agents and responses to questions about mental health, interpersonal violence, and physical health. *JAMA internal medicine* 176, no. 5: 619-625. DOI: https://doi.org/10.1001/jamainternmed.2016.0400
30. Andreea I. Niculescu, Kheng Hui Yeo, Luis F. D'Haro, Seokhwan Kim, Ridong Jiang & Rafael E Banchs. 2014. Design and evaluation of a conversational agent for the touristic domain. *In Proceedings of APSIPA'14*: 1–10. DOI: https://doi.org/10.1109/APSIPA.2014.7041744
31. Pierre Philip, Jean-Arthur Micoulaud Franchi, Patricia Sagaspe, Etienne de Sevin, Jérôme Olive, Stephanie Bioulac, and Alain Sauteraud. 2017. Virtual human as a new diagnostic tool, a proof of concept study in the field of major depressive disorders. *Scientific Reports*. 7. 42656. DOI: https://doi.org/10.1038/srep42656.
32. Stefan Priebe, Michelle Richardson, Maire Cooney, Oluwatoyin Adedeji, and Rosemarie McCabe. 2011. Does the therapeutic relationship predict outcomes of psychiatric treatment in patients with psychosis? A systematic review. *Psychotherapy and Psychosomatics* 80, no. 2: 70-77. DOI: https://doi.org/10.1159/000320976
33. Simon Provoost, Ho Ming Lau, Jeroen Ruwaard, and Heleen Riper. 2017. Embodied conversational agents in clinical psychology: a scoping review. *Journal of medical Internet research* 19, no. 5: e151. DOI: https://doi.org/10.2196/jmir.6553
34. Hyekyun Rhee, James Allen, Jennifer Mammen, and Mary Swift. 2014. Mobile phone-based asthma self-management aid for adolescents (mASMAA): a feasibility study. *Patient preference and adherence* 8: 63. DOI: https://doi.org/10.2147/PPA.S53504
35. Joel Sebastian and Deborah Richards. 2017. Changing stigmatizing attitudes to mental health via education and contact with embodied conversational agents. *Computers in Human Behavior* 73: 479-488. https://doi.org/10.1016/j.chb.2017.03.071
36. Takanori Shibata and Kazuyoshi Wada. 2011. Robot therapy: a new approach for mental healthcare of the elderly–a mini-review. *Gerontology* 57, no. 4: 378-386. DOI: https://doi.org/10.1159/000319015
37. Aditya N. Vaidyam, Hannah Wisniewski, John David Halamka, Matcheri S. Kashavan, and John Blake Torous. 2019. Chatbots and conversational agents in mental health: a review of the psychiatric landscape. *The Canadian Journal of Psychiatry* 64, no. 7: 456-464. DOI: https://doi.org/10.1177/0706743719828977

38. Frank M.F. Verberne, Jaap Ham, Aditya Ponnada, and Cees J. H. Midden. 2013. Trusting digital chameleons: The effect of mimicry by a virtual social agent on user trust. In *International Conference on Persuasive Technology*, Springer, Berlin, Heidelberg, 234-245. DOI: https://doi.org/10.1007/978-3-642-37157-8_28

39. Frank M.F. Verberne, Jaap Ham, and Cees J.H. Midden. 2015. Trusting a virtual driver that looks, acts, and thinks like you. *Human factors* 57, no. 5: 895-909. DOI: https://doi.org/10.1177/0018720815580749

40. Maria K. Wolters, Fiona Kelly, and Jonathan Kilgour. 2016. Designing a spoken dialogue interface to an intelligent cognitive assistant for people with dementia. *Health informatics journal* 22, no. 4: 854-866. DOI: https://doi.org/10.1177/1460458215593329

41. Jin Xu, G. Bryant De'Aira, and Ayanna Howard. 2018. Would You Trust a Robot Therapist? Validating the Equivalency of Trust in Human-Robot Healthcare Scenarios. In *2018 27th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 442-447. IEEE. DOI: https://doi.org/10.1109/ROMAN.2018.8525782

42. Zhe Zhang, Timothy W. Bickmore, and Michael K. Paasche-Orlow. 2017. Perceived organizational affiliation and its effects on patient trust: Role modeling with embodied conversational agents. *Patient education and counseling* 100, 9: 1730-1737. DOI: https://doi.org/10.1016/j.pec.2017.03.017