Dec 11th, 12:00 AM

Affect between Humans and Conversational Agents: A Review and Future Research Directions

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Short Paper

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Abstract

Conversational agents (CAs) are digital artifacts which communicate with humans through natural language for performing a variety of tasks. When humans interact with CAs, affective responses e.g., emotions, are seen to influence both CA adoption and performance. Despite the vital role of affect in human-CA interaction, understanding of its antecedents, affective outcomes, and their relationships from prior research is nascent and segregated. Motivated thus, we review empirical studies on affect in human-CA interactions, classify them in terms of affective outcomes, and identify corresponding antecedents. We further analyze the relationships between antecedents and outcomes and highlight significant relationships as well as inconsistent findings. Drawing on the review, we propose future research directions for this area. We contribute by developing a deeper understanding of research on affect between human and CAs, identifying gaps in prior knowledge, and outlining future research directions. Additionally, we lay out our plans for extending this work.

Keywords: *Conversational Agent (CA), Human-CA Interaction, Affect, Emotion, Literature Review, Research Agenda*

Introduction

Conversational agents (CAs) are digital artifacts that interact with humans through natural language (Diederich et al. 2022) e.g., the popular ChatGPT. These agents are increasingly being utilized across many sectors like education, healthcare, and e-commerce, for a variety of tasks (Zierau et al. 2020). Common CA tasks include personal assistance, such as booking appointments or buying products using Apple's Siri (Rhee and Choi 2020) and business activities, such as customer service using chatbots (Ashktorab et al. 2019). CAs can potentially deliver significant value and cost savings to individuals and businesses, but also face challenges in adoption and performance.

This has led to growing research interest in human-CA interactions. Particularly, literature reviews have examined research on human-CA interactions in general (e.g., Diederich et al. 2022), specific application contexts like education (e.g., Weber et al. 2021) and CA design, such as social cues (e.g., Feine et al. 2019) and text-based communication (e.g., Rapp et al. 2021). However, one critical aspect that requires further attention in human-CA interactions is affect, which refers to the underlying experience of emotion or feelings (Barrett and Bliss-Moreau 2009). Affect serves as a major guiding force in human perception and decision making, such as decisions to adopt new information systems (Jeon 2017) like CAs. Individuals could be motivated to continue using a CA if they enjoyed their interactions with it. For example, Microsoft's social chatbot Xiaoice has attracted millions of users because of its empathetic and friendly personality, which users enjoy interacting with (Spencer 2018). Further, CAs designed to detect and express emotion

can enhance their task performance, such as supporting user's well-being (Ghandeharioun et al. 2019). Thus, understanding the nature of affect in human-CA interactions is vital for designing CAs to enhance user experiences and CA performance (Yang et al. 2019). While prior reviews have added to our knowledge, an understanding of research on affect between human users and CAs is lacking. Motivated thus, it is important to review and summarize the findings on affect in human-CA interactions in a holistic way to inform research in this area. Hence, we focus on the following research question (RQ): *What is the state of research findings regarding affect in human–CA interaction?*

To address this question, we conduct a review of information systems (IS) and human-computer interaction (HCI) empirical studies, which examine affect between humans and CAs quantitatively. Based on our review, we categorize independent (IVs) and dependent variables (DVs) and identify their relationships. The findings are synthesized into three descriptive models of different affective outcomes and their antecedents. We then identify knowledge gaps and propose future research directions on this topic. We contribute by developing a cumulative understanding of findings and unexplored areas to aid research in this topic.

Conceptual Background

Conversational Agents

CAs represent a novel form of IS that aim to mimic human communication with a high degree of interaction and intelligence (Feine et al. 2019). CA design components have been examined to achieve these objectives. Zierau et al. (2020) classified CA design elements into five basic categories i.e., verbal, visual, auditory, invisible, and interaction. The *verbal* category includes elements that are expressed through words in either written or spoken form, such as conversation style and content. The *visual* and *auditory* categories describe elements that interact via humans' vision (e.g., CA embodiment) and hearing (e.g., voice quality), respectively. CA design elements that cannot be sensed directly by hearing, seeing, or words, such as CA personality, are considered as *invisible*. The *interaction* category refers to elements representing the interaction structure e.g., communication mode being text or speech (Zierau et al. 2020). We use this common classification to organize the IVs related to CA characteristics in our review.

Affect Related Concepts

Affect, defined as an encompassing term that includes emotions, moods, and feelings, is gaining importance as a research area (Diederich et al. 2022). Early views of affect have represented it as a set of discrete basic emotions, such as anger and happiness (Ekman 1992). However, as basic emotions are unable to explain some aspects of affect, other key dimensions were added. The circumplex model (Russell 2003) suggested two such dimensions i.e., *valence* (positive/negative reaction to stimulus), and *activation* (degree of arousal). To explain the affect between human and IS (such as CAs), Zhang (2013), proposed the affective response model, by extending the circumplex model of affect. Zhang (2013) classified affective concepts into 3 groups based on where their meanings reside: within a person (i.e., has little to do with a stimulus), within a stimulus (i.e., has little to do with the user) and between a person and stimulus (e.g., human interaction with CAs). Affective concepts residing between a person and stimulus are particularly relevant to this study, and were further categorized as: *emotions, affective evaluations, perceived affective quality, attitude,* and *affective response*. *Emotion* refers to a state induced by or attributed to a specific stimulus (Zhang 2013), which is usually episode-based and short-lived (Russell 2003) e.g., emotions evoked during humans-CA interaction. *Affective evaluation* is a general term which includes humans' affect-related appraisal of the stimulus (e.g., enjoyment of CA interaction), as well as their perception of stimulus' affective quality or *perceived affective quality* (e.g., likeability of the CA). *Attitude* is defined as the overall evaluation of a stimulus that can guide behavior towards that stimulus (Zhang 2013) e.g., like or dislike of interacting with the CA. *Affective response* includes both *emotion* and *affective evaluation (*Zhang 2013*)*. Thus, we dropped the *perceived affective quality* and *affective response* categories to avoid overlap with *affective evaluation* and *emotion* respectively. Accordingly, we utilize three out of the five categories of affective concepts i.e., *emotion, affective evaluation,* and *attitude*, to classify the affect-related DVs in this review.

Research Methodology

Since our review is about an emerging topic of affect in human-CA interaction and driven by a generic research question, we conducted a scoping literature review (Templier and Paré 2015). We followed the

prescribed steps for such reviews i.e., formulating the problem (research question), searching and screening the literature for inclusion, assessing quality, coding to extract data, followed by analysis and synthesis.

Paper Search and Selection

The paper search and screening processes were conducted in four phases as per PRISMA i.e., identification, screening, eligibility, and inclusion (see Table 1). In the *first* phase, we formed the search query and identified relevant outlets. The search query consisted of two parts: the first part included synonyms and related terms of CA, while the second part comprised the earlier-mentioned key concepts of affect and related terms. No date restrictions were imposed during the search. For search outlets, we focused on IS and HCI journals and conferences, since these two fields are the main sources of human-CA interaction studies (Zierau et al. 2020). To ensure the quality of papers, we considered reputed (rank 1 and rank 2) journals and conferences from established ranking lists (CORE, AJG, AIS Basket of Eight). The next two phases consisted of screening based on the inclusion and exclusion criteria, where the *second* phase involved screening papers by abstracts and keywords, and the *third* phase checked eligibility based on full texts of papers, from the second phase. We included empirical papers that examined affect in human-CA interactions. We developed several exclusion criteria to guide the screening. As we aim to provide an integrated view of the empirical findings, we excluded papers that did not have empirical findings e.g., lit review, or were qualitative in nature (criterion 1). We also excluded papers that studied only one-way communication between humans and CAs, as we examine affect for conversations (defined as a two-way dialog) between them (criterion 2). Papers that adopted Wizard-of-Oz settings were excluded (criterion 3) as there is: (1) risk of cognitive fatigue and compromised (humanlike) responses by the CA over time (Mast et al. 2023), and (2) risk of participants finding out it is a human rather than a CA (Robinson et al. 2018). Studies that asked respondents to evaluate the interaction based on imagination rather than actual interaction (criterion 4) were also excluded, as scenario-based research might not produce strong affective reactions resulting in inaccurate effect estimations (Robinson and Clore 2002). Last, we excluded papers that didn't provide full findings with statistical results (criterion 5). In the *fourth* phase, we performed a backward search of the selected papers to uncover relevant studies that did not appear in the database search. As a result, a final set of 64 papers were identified for our review. The full list of papers is given at: (https://drive.google.com/drive/folders/108plTm70DOFG7OBdeWnn9fT4bnH7zopB?usp=sharing)

Search Query	**Identification**	(((Conversational OR Interactive OR Virtual OR Digital OR AI OR Artificial) AND (Agent OR Assistant)) OR Chatbot OR Bot) AND (Affect OR Emotion OR Feel OR Attitude OR Mood OR Temperament OR Sentiment)
Initial Results	**Identification**	351 papers
Inclusion Criteria	(1) Paper examines human-CA interaction. Chatbot is often used as synonym (2) Paper studies human users' and/or CAs' affect quantitatively	
Exclusion Criteria	(1) Paper is not empirical (e.g., literature review) or is qualitative (2) Paper studies one-way communication between human and CA rather than two-way conversation (e.g., students watching a video of a pedagogical agent) (3) Paper adopts *Wizard-of-Oz* setting where CAs are not truly automated (i.e., subjects perceive the responses as coming from CAs, but are actually replied by human researchers) (4) Paper asks users to evaluate the CA by only imagining their interaction with it (e.g., through looking at CAs' images or scenarios, not actual dialogues) (5) Paper doesn't provide full findings with statistical results	
Results based on criteria	**Screening**	After abstract, keywords scan and filtering (second stage): 198 papers
	Eligibility	After full-text scan and filtering (third stage): 61 papers
	Inclusion	After backward search (fourth stage): 64 papers (final sample)

Table 1. Paper Search and Selection Process

Paper Coding and Analysis

Two authors independently coded each paper for the IVs, DVs and their relationships. The affective variables identified from the studies were checked for inconsistent definitions and meanings. Only the findings for validated variables were retained. The coding was discussed between the two authors, and any

discrepancies were resolved in consultation with the third author. We adopted Zierau et al.'s (2020) classification of CA design elements to code our CA-related IVs, supplemented by our own categories as needed. We drew on the three categories of affective responses derived from Zhang (2013) i.e., *emotion, affective evaluation, and attitude*, to classify the DVs. We coded 126 relationships between the IVs and DVs, of which 88 were positive, 12 were negative, and 26 were not significant (i.e., not $p < 0.05$).

Results

We present our findings in four sections. The first section reports descriptives of the papers reviewed, while the second and third sections describe papers where affective concepts appeared as antecedents (IVs) and outcomes (DVs) respectively. The last section presents our three synthesized descriptive models that show the relationships and findings between the antecedents and affective outcomes.

Descriptives

Although we found studies on affect between humans and CAs from 2007, our review shows a significant rise in studies on this topic from 2017, emphasizing the recent interest in this topic. Our review includes 38 journal papers and 26 conference papers. It is worth noting that the majority of the papers (85%) were published in HCI outlets like *IJHCI, IJHCS,* and *Computers in Human Behavior,* while the IS outlets included *ISR, JAIS, JMIS, ICIS, AMCIS,* and *ECIS*. The papers examined *application contexts* such as customer service (34%), social CAs (31%), personal assistants (12%), healthcare (10%), and education (6%). The studies mostly used experiments (78%), followed by surveys (19%), or both (3%) as *research methods*.

Affect as Antecedents

Of the 64 reviewed papers, 11 studies (17%) examined affect between humans and CAs solely as antecedents. Among these studies, 7 studies explored how a CA detecting or expressing emotions influenced human perceptions towards the CA, increased trust towards the CA, and user learning outcomes (e.g., Huber et al. 2018). Further 2 studies explored the positive impacts of human attitude and enjoyability on trust towards the CA and self-disclosure, while one study examined the moderation effect between human pre-interaction emotion (embarrassment) and CA social presence on intention to use the CA (Mozafari et al. 2021). The remaining paper studied the relationship between human control over an emotion-detecting CA and its positive effects on human autonomy (Benke et al. 2022).

Affect as Outcomes

Of the 64 papers, 53 studies (83%) explored affect between humans and CAs as outcomes, including 16 papers that studied affect-related concepts as both antecedents and outcomes. While we classified affective outcomes into three categories, one paper may discuss more than one category i.e., the percentages add up to > 100%. In total, 24 papers (45%) studied *emotion* as the outcome. Among these, almost all (23) papers examined *human emotion* as the interaction outcome. Studies focused on *specific human emotions*, such as anxiety, frustration, harassment, stress, interest, and joy (e.g., Chin and Yi 2019) and different dimensions of emotions, including *valence* and *activation*. *Human emotional connection*, *engagement*, and *warmth* (e.g., Stein et al. 2020) were also studied. Interestingly, 1 paper examined *CA's emotion* as the interaction outcome (Huber et al. 2018).

Another commonly studied outcome category is *affective evaluation*, constituting 67% of the 53 papers. DVs describing humans' evaluation including *satisfaction* (both satisfaction with the CA and satisfaction with the business employing the CA), *enjoyment, fun*, and *affective trust* (e.g., Chin and Yi, 2019). Outcomes related to CA's affective quality include CA's perceived *attractiveness*, *likability*, *uncanniness or eeriness*, *empathy*, *emotional intelligence,* and *hedonic quality* (e.g., Song and Shin 2022). The third outcome category is *attitude*, in 17% of the 53 papers. Researchers have examined user attitude towards the CA, attitude towards the business employing the CA, and attitude towards a disease after learning about it from the CA (e.g., Choung et al. 2022).

Descriptive Models for Relationships between Antecedents and Affective Outcomes

In this section, we explore the antecedents for different affective outcomes through a synthesis of prior findings. We synthesized the 126 findings into three descriptive models based on the categories of affective

outcomes between humans and CAs i.e., *emotion, affective evaluation*, and *attitude*. The models also reveal that different affective outcomes interact and influence each other. We also analyzed the consistency of findings across the reviewed papers and summarized them in the models (see Figures 1-3). In many cases, there were multiple findings for an antecedent. We used "***inc***" to indicate an antecedent with inconclusive findings, i.e., equal number of significant and non-significant relationships (50% each). If the findings about the antecedent were not significant (i.e., more than 50% findings were not significant), it was labeled as "***ns***". We labeled the antecedent as "***mix***" if it was significant but had mixed findings (equal number of positive and negative findings). We marked the antecedent as "+" if the findings were significant and positive (i.e., more than 50% of the findings were positive) and "**-**" if the findings were significant and negative (i.e., more than 50% of the findings were negative). When there was only one finding for an antecedent, we marked it as "***1***" to show limited evidence. When the findings were significant and comparative e.g., comparing different conversation styles, we marked the antecedent as "*".

Overview of Antecedents of Affect

The antecedents of affective concepts included human, CA, and task characteristics, as well as other factors. The first category is *human characteristics*, which captures user factors that impact affect between humans and CAs. The second category is *CA characteristics*, which covers its basic design elements and other CA features. The *basic design elements* fall into verbal, visual, auditory, invisible, and interaction categories as discussed before. Additionally, four *other features* were studied as antecedents i.e., CA anthropomorphism, CA personalization, CA detecting human emotion, and CA expressing emotion. The third category of antecedents is *task characteristics*, which indicates how different task types could influence affect. The fourth category is *other factors*, which includes antecedents not captured by the other categories, such as time, comparison between CAs and humans, or between CAs and other applications.

Antecedents of Emotion

We synthesized 50 findings and classified them into 18 antecedents of emotion from the reviewed papers in Figure 1. The antecedents were classified into the four categories mentioned above. The reviewed papers offer evidence that *human characteristics* influence emotion in humans during interaction - from 6 findings. Among these, while the findings about verbal abuse type and affective quality (effects of sociability of CA were negative on anxiety and not significant on fear) were inconclusive, culture (eastern), and user satisfaction were seen to positively impact users' emotion. With respect to *task characteristics*, CA use scenarios and cooperative human-CA tasks were studied. For instance, users requesting basic information from a CA felt less positive emotion than using it to access external services (Yang et al. 2019). In terms of *other factors*, research comparing CAs' versus human assistants' impact on user emotions obtained mixed findings (2 positive, 2 negative). Studies also examined the role of time, where users' emotional arousal increased with time when interacting with a CA displaying social cues (Huang and Lee 2022). Additionally, most *CA characteristics* were important determinants of emotion - from 35 findings. Here, four basic CA design elements i.e., verbal, invisible, visual, and interaction were studied. While the visual element i.e., CA embodiment, had no impact on user emotion (Stein et al. 2020), the remaining three design elements were found significant. For example, verbal empathy of a CA increased positive human emotion (Chin et al. 2020), while CA interaction using facial expressions enhanced users' emotional engagement compared to speech interaction (Shi et al. 2018). Last, *other CA features* including anthropomorphism, personalization, emotion detection or expression capability were explored. In general, CAs with higher anthropomorphism and personalization reduced negative emotion and increased emotion activation. One study with CA's emotion as outcome found that detecting user emotions led to higher emotional valence (Huber et al. 2018).

Antecedents of Affective Evaluation

We synthesized 58 findings and classified them into 24 antecedents of affective evaluation from the reviewed papers in Figure 2. The antecedents were classified into the four categories mentioned above. The reviewed papers offer evidence that *human characteristics* influence affective evaluation - from 13 findings. Among these, only the findings about users' experience with CA were inconclusive i.e., one positive finding on CA attractiveness and one insignificant finding on the effect of hedonic quality of CA. Users' gender was a significant antecedent of CA's affective evaluation. For instance males preferred CAs with ingratiation techniques (flattery), trusted male embodied CAs to have more expertise and power than female CAs. Also, users' emotion (pre interaction emotion and positive emotions due to CA response) and perception of CA's

affective quality (sociability and perceived anthropomorphism) were seen to impact their affective evaluation of the CA positively i.e., other types of affect influenced affective evaluation. Users' age, working alliance (trust and confidence of working with CAs), and familiarity with the CA were significant IVs in single studies. Familiarity with a CA's appearance e.g., like that of a celebrity, enhanced affective evaluation by reducing the feeling of eeriness towards the CA (Song and Shin 2022). With respect to *task characteristics*, the comparison between the effect of cooperative vs. competitive human-CA task on affective evaluation was inconclusive, while a CA assisting in functional tasks increased the affective evaluation as compared to social tasks (Lee et al. 2021). In terms of *other factors*, researchers compared CAs with human assistants, but the findings were inconclusive. One study compared CAs with other applications and found that a CA-equipped TV was more attractive than a TV remote control (Lee et al. 2020). Furthermore, most *CA characteristics* were important antecedents of CA's affective evaluation - from 37 findings. Here, all five design elements were found to be significant antecedents of affective evaluation. For example, a study on visual elements revealed that a visual interface led to a higher perception of CA attractiveness than a text interface (Stein et al. 2020). Regarding auditory design elements, a study found that a CA with audio-gamification increased users' perception of fun (Bräuer and Mazarakis 2022). Beyond the basic design elements, *other features* of CAs were explored. In general, a CA having higher personalization, emotion detection or expression capability enhanced its affective evaluation. However, the findings regarding CA anthropomorphism were mixed (1 positive, 1 negative) i.e., it could increase or decrease CA's affective evaluation because of its humanlike appearance or its eeriness.

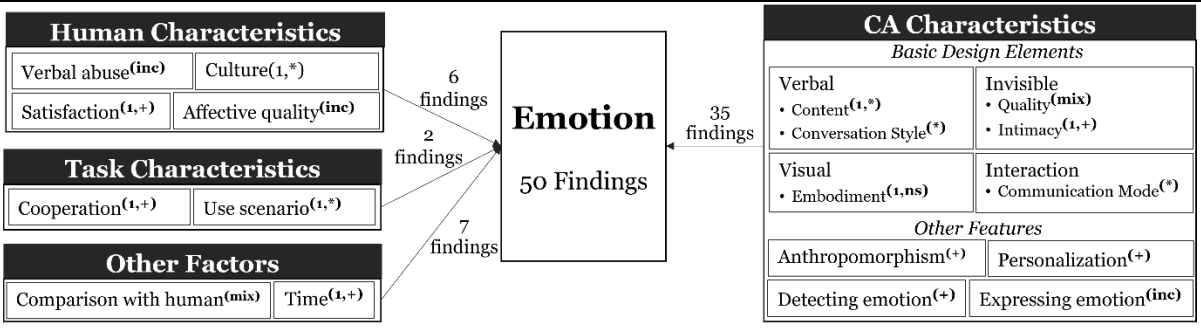

Figure 1. Antecedents of Emotion

Beyond Figure 2, there were 7 more findings on moderation effects between antecedents on CA's affective evaluation. Most findings explicated the interaction effects between CA characteristics and the other three categories of antecedents. One study found an interaction between two CA characteristics. It reported that for a humanlike embodied CA, higher CA intelligence induced more eeriness (Stein et al. 2020).

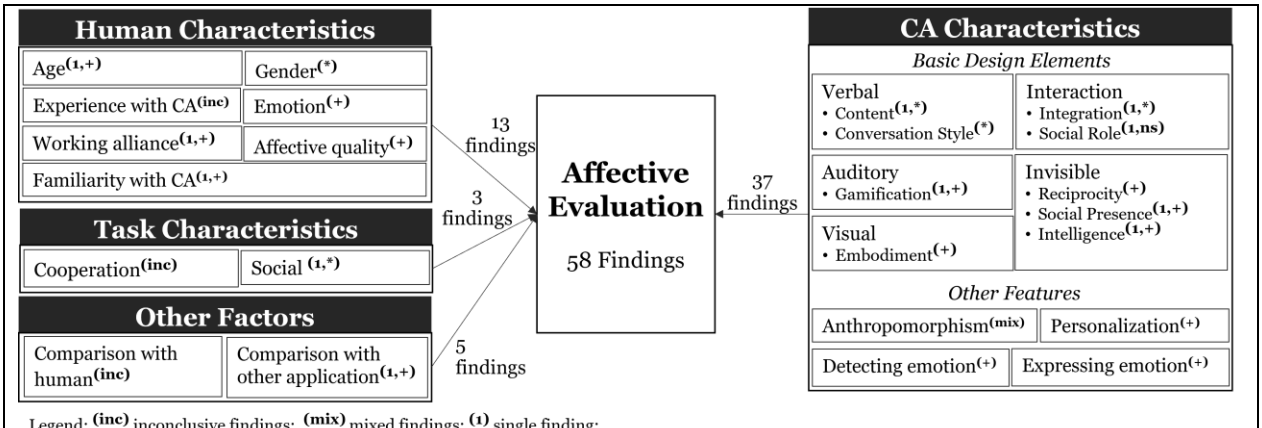

Figure 2. Antecedents of Affective Evaluation

Antecedents of Attitude

We synthesized 18 findings and classified them into 16 antecedents of attitude from the reviewed papers in Figure 3. The antecedents were classified into three categories, as task characteristics were not studied. The reviewed papers offer evidence that *human characteristics* influence attitude - from 5 findings. Here, users' ethical ideology i.e., those with high idealism, belief in machine heuristic, higher usage power, and trust towards CA, positively influenced attitude. Perceived affective quality (perceived coolness of the CA) also had a significant impact on user's attitude towards the CA. In terms of *other factors*, researchers examined the impacts of the use of CA, the role of time, and product involvement on attitude. For instance, user's attitude towards the CA was enhanced over time if the user perceived a positive emotion towards the CA (Huang and Lee 2022). *CA characteristics* were important determinants of attitude. Here, four basic design elements (except auditory) were studied. Particularly, verbal, invisible, and interaction design elements were found to be significant antecedents of attitude, as opposed to visual elements. For example, invisible elements including CA's ease of use and usefulness were positively related to user's attitude towards it (Choung et al. 2022). In addition to the basic design elements, the effects of *other features* i.e., anthropomorphism and personalization, were explored. Researchers found personalization enhanced attitude, but the effect of anthropomorphism was not significant. Further, product involvement enhanced the positive effect of CA's personalization on user's attitude towards the CA (Rhee and Choi 2020).

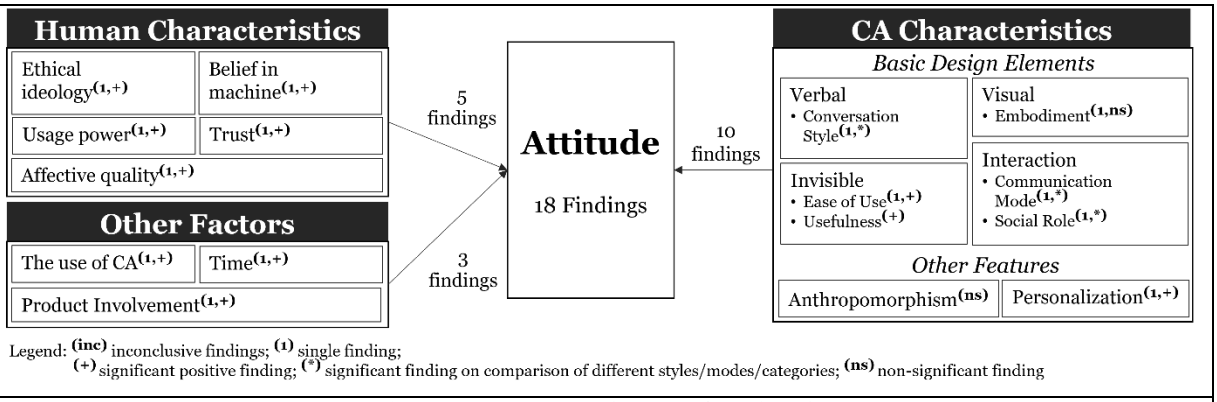

Figure 3. Antecedents of Attitude

Discussion and Future Research Directions

Understanding the nature of affect between humans and CAs is crucial to design effective CAs (Yang et al. 2019). Motivated thus, we conducted a literature review to identify and cumulate findings from prior research on affect in human-CA interactions. We conducted a holistic examination of prior quantitative studies on this topic and synthesized the findings into three descriptive models. These models present the current state of findings on the antecedents of three key affective outcomes. We outline future research avenues based on our review by examining each set of results and identifying areas that require explication.

Our *descriptives* show that IS outlets lag in publishing research on affect in human-CA interactions. As CAs gain popularity, it becomes important to understand how human affect develops towards them in the short and long-term, eventually impacting CA adoption, performance, and downstream outcomes. IS research is well-positioned to do so. In terms of *methodology* used, persistent affect like attitude has mostly been captured with single experiments or surveys. This calls for longitudinal studies to assess how these perceptions evolve with multiple CA interactions over time, and impact adoption and effective use. Findings about *affect as an outcome* reveal that only one study focused on specific positive emotions (e.g. joy) as outcomes. Future research can examine different CA design elements that evoke positive emotions in humans, as it can promote CA usage and adoption in the long term (Beaudry and Pinsonneault 2010). With respect to findings about *affect as an antecedent*, research assessing the affective state i.e., mood, temperament, of human users is lacking. Since, users' mood or temperament can influence their affective responses during interactions with CAs (Zhang 2013), these concepts require further investigation. With respect to *antecedents of affect*, studies on the effects of *human characteristics* like age, gender, personality and culture on emotion (only 1 study) and attitude (no studies) are limited. These characteristics may significantly influence how humans perceive and interact with CAs (Diederich et al. 2022). Hence, future

research could investigate the impact of individual user characteristics on affective responses, which could also aid in the personalization of CAs. We also found scant research on the effects of *task characteristics* on affective responses. As CAs are being used for a variety of tasks (Diederich et al. 2022), it would be useful to examine and understand at a granular level how the nature of the task influences affective outcomes. Among studies of how *CA characteristics* impact affect, we found that research examining the influence of auditory elements (e.g., CA voice quality, tone) is lacking, with only one study on this topic. With the increasing popularity of voice activated CAs (e.g., Rhee and Choi 2020), there is a need for future research to understand the impacts of their auditory elements on affective outcomes. *Last*, a number of IVs showed inconclusive, mixed, or insignificant relationships with affective outcomes across the three frameworks. These motivate future research to examine the conditions/moderators under which these relationships manifest and their underlying mechanisms. For instance, interaction between cognitive and affective evaluations of a CA could be examined.

Contributions and Future Plans

Despite utilizing established guidelines and analyses, this review has a few limitations. *First*, findings for different CA application contexts e.g., healthcare, and different CA modalities (or their combinations) were not analyzed, which is planned in our future work. This would allow us to gain a deeper understanding about human-CA affect in given contexts and with specific modalities. Second, despite efforts to conduct an exhaustive review we might have missed relevant publications, for which an expanded list of outlets (e.g., the Senior IS Scholars List of Premier Journals) would be considered. *Third,* a meta-analysis of specific relationships and moderation effects could be carried out in future, so that researchers can better understand how each antecedent would impact specific affective concepts in human-CA interactions. Last, future research to hypothesize and test different nomological nets by inter-relating the three DVs with specific sets of antecedents and outcomes will be valuable.

Nevertheless, this study contributes towards a holistic understanding of the state of findings on affect between humans and CAs by surveying relevant literature in the IS and HCI fields. We present three models depicting the relationships between antecedents and affective outcomes of human-CA interactions. This can assist researchers working in or planning to work in this area. With the increasing popularity of CAs along with the challenges of using them, we expect to see burgeoning research interest in this area.

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