HEALTH SYSTEMS
2019, VOL. 8, NO. 1, 31–43
https://doi.org/10.1080/20476965.2017.1406568

ORIGINAL ARTICLE

I want to talk to a real person: theorising avoidance in the acceptance and use of automated technologies

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ABSTRACT

Automated communication systems are increasingly common in mobile and ehealth contexts. Yet, there is a reason to believe that some high-risk segments of the population might be prone to avoid automated systems even though they are often designed to reach these groups. To facilitate research in this area, avoidance of automated communication (AAC) is theorised – and a measurement instrument validated – across two studies. In study 1, an AAC scale was found to be unidimensional and internally reliable as well as negatively correlated with comfort, perceptions, and intentions to use technology. Moreover, individuals with social phobia had lower AAC scores which was consistent with the idea that they preferred non-human interaction facilitated by automated communication. In study 2, confirmatory factor analysis supported the unidimensional structure of the measure and the instrument once again proved to be reliable. Individuals with lower AAC had greater intentions to utilise automated communication, EHRs, and an automated virtual nurse programme. AAC is a disposition that predicts significant variance in intentions and comfort with various automated communication technologies. Avoidance increases with age but may be mitigated by systems that allow participants to opt-out or immediately interact with a live person.

ARTICLE HISTORY
Received 22 August 2016
Revised 15 October 2017
Accepted 13 November 2017

KEYWORDS
Avoidance; automated communication; electronic health record; virtual nurse; humancomputer interaction

1. Do some people avoid automated communication technologies? Validating an avoidance of automated communication (AAC) scale

The information age began in the 1950s with the introduction of computer technology. Rogers (1986) noted that one component of the industrial age that continued to flourish during the information age was automation. Automation is a challenging term to define, but most agree that it is the use of machines "to execute or help execute physical operations, computational commands or tasks" (Nof, 2009, p. 43), such as automated nurse rostering (Mihaylov, Smet, Van Den Noortgate, & Vanden Berghe, 2016), automated writing evaluation (e.g., Roscoe, Wilson, Johnson, & Mayra, 2017), virtual research assistants (e.g., Hasler, Tuchman, & Friedman, 2013), automated bots (e.g., Clément & Guitton, 2015; Edwards, Beattie, Edwards, & Spence, 2016), and automated health systems (e.g., Farzanfar, Frishkopf, Friedman, & Ludena, 2007). Rogers observed that during the information age automation was materialising in new arenas, including communication. For example, automated teller machines (ATMs) blurred the boundaries between interpersonal and mass communication, and led Rogers to speculate that automated communication technologies (ACTs) would rapidly increase in the decades ahead and that understanding the adoption and use of such technologies would become a central part of communication research (Rogers, 1986).

In line with Roger's predictions, the number and type of ACTs have dramatically increased since that time. For instance, ATMs tripled in number from the 1980s to the 2000s, and similar growth has been observed for other ACTs (Velásquez, Chen, Yoon, & Ko, 2009) including rapid growth online (Papsdorf, 2015). Recently, researchers have developed and evaluated more nuanced automated communication devices for health contexts, such as the virtual nurse programme that can perform basic health care routines via a flat screen interface (Bickmore, Pfeifer, & Paasche-Orlow, 2009), a health care check-out system that reduces provider data-entry error (Frank, Lawless, & Steinberg, 2005), and computer physician order entry (Kuperman & Gibson, 2003). Importantly, many of these ACTs are designed to play a

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role in patient education and management. For example, health care providers could use ACTs to inform their eligible patients that it is time to screen for colon cancer or to as part of check-in/check-out (Dey, 2009).

Though increasingly common, automated communication is not without fault. Communication is a complex human behaviour which may hinder the construction of life-like computer algorithms (Moore, 2001). Indeed, ACTs may be less sensitive to conversation shifts or user goals (Whitworth, 2005). Consistent with this idea, past attempts to develop effective automated communication interfaces have been more prone to failure than success. For example, Microsoft's automated anthropomorphous paper clip assistant – Clippy – frustrated and annoyed users and ultimately was labelled a failure (Dey, 2009; Veletsianos, 2007).

Due to these problems, automated communication may be viewed negatively by segments of the public and perhaps even actively avoided (Reppenger & Phillips, 2009; Whitworth, 2005). Avoidance of automated communication (AAC) is defined here as actively ignoring, skipping, or terminating messages that appear to originate from interactive communication databases. AAC is a cultivated disposition that can stem from personal, vicarious, or perceived experiences. Of concern, it is possible that avoidance could be heightened in high-risk groups – low literacy populations, older individuals – that ACTs are often designed to serve (Jensen, King, Davis, & Guntzviller, 2010). For instance, the virtual nurse check-out system (Bickmore et al., 2010; Bickmore, Schulman, & Sidner, 2013) is designed to facilitate meaningful patient check-out, notably for individuals who may require additional support due to educational and/or communication deficits. If those same populations are prone to AAC, then such interfaces may need to be modified to account for dispositional avoidance as well as educational/communication deficiencies.

Given that automated communication is at the centre of many innovative communication advances it is imperative that researchers theorise when and how it might influence acceptance and use of technology. Over two studies, a measure of AAC is proposed and evaluated, and relationships between AAC and other known predictors of technology use are examined (Venkatesh, Morris, Davis, & Davis, 2003). Understanding when and why individuals avoid automated communication will facilitate optimal design and adoption of automated technologies.

2. Study 1

AAC is a context-specific construct for researchers' study the adoption and use of automated communication technologies (ACTs; Bickmore et al., 2009; Reppenger & Phillips, 2009; Whitworth, 2005). Automated communication occurs when an interactive database is constructed to imitate human communication. Examples of ACTs include interactive telephone menus and automated teller machines (ATMs). ACTs have the potential to significantly influence the speed and efficiency of information systems if they are adopted successfully by the target population.

Based on past research (Venkatesh et al., 2003) and a conceptual understanding of AAC, it is possible to initially theorise several relationships. AAC should be negatively correlated with performance expectations and effort expectations, including perceived ease of use, perceived usefulness, personal involvement, and playfulness (Agarwal & Karahanna, 2000; Agarwal & Prasad, 1998; Davis, 1989). Likewise, AAC should be negatively correlated with comfort with technology (Rodriguez, Ooms, & Montañez, 2008) and cognitive absorption (Agarwal & Karahanna, 2000) in that avoidance should stem, in part, from a lack of comfort and absorption (Agarwal & Karahanna, 2000; Agarwal & Prasad, 1998; Davis, 1989). Finally, those with greater AAC should be less willing to use automated communication devices including those integrated into health care contexts. For instance, health systems researchers are interested in the acceptance and use of electronic health records (EHRs) (Papuga et al., 2017; Tarrell, Grabenbauer, McClay, Windle, & Fruhling, 2015; Weeger & Gewald, 2015); individuals with high avoidance should be less favourable to automated components of EHRs.

Research on AAC is non-existent as there are no measures of the construct. Thus, it is necessary to develop a valid measure of AAC to facilitate additional research. Validating a measurement instrument is a multi-step process. One of the first steps is examining whether scores from the new instrument are correlated with scores from other known measures in predictable ways (DeVellis, 2003; MacKenzie, Podsakoff, & Podsakoff, 2011). AAC should be positively correlated with communication avoidance in general (Donovan-Kicken & Caughlin, 2010); however, one exception to this could be individuals with social phobia.

Social phobia is an anxiety disorder wherein individuals have extreme fear of or discomfort in social situations (Liebowitz, 1987; Rapee & Heimberg, 1997). Clinical levels of social phobia exist in approximately 12.1% of the population (Ruscio et al., 2008). Individuals with social phobia may be extremely anxious about public speaking, talking with groups of people, or interacting with others (Rapee & Abbott, 2007). Due to this anxiety, individuals with social phobia may come to prefer non-human or non-face-to-face communication situations (Pierce, 2009). For example, social phobia could compel a person to communicate more intimate information to a virtual nurse as compared to a real nurse (Kang & Gratch, 2010). Thus, social phobia is an ideal construct for validating AAC, as individuals with this condition should be less avoidant of ACTs, which is counter to how they normally respond in interpersonal communication situations.

2.1. Method

2.1.1. Participants

Undergraduate students (N = 153) voluntarily participated in a survey for extra credit. More males (66.0%) participated than females (34.0%). The mean age of participants was 21.14 years (SD = 2.69). The racial background of participants was 72.5% Caucasian, 11.1% Asian, 3.9% Hispanic, 5.2% black or African American, .7% American Indian, 5.9% describing themselves as "other", and one missing data.

2.1.2. Procedure

Participants were students enrolled in communication courses at a large university in the Midwestern United States. Communication courses fulfil general educational requirements, so the students in this study represent a wide range of majors. At their discretion, course instructors presented students with the opportunity to earn extra credit (equal to 3% of their final grade) by participating in department research studies. Interested students visited the research participation website and signed up to participate. Participants who were ready to complete the study had the option to connect to the study website and complete the survey (for .5% extra credit). Those visiting the website read a consent form, agreed to participate in the study, and then completed a series of demographic and psychosocial items. All research procedures were approved and oversaw by an institutional research board.

Because many participants may not have been familiar with several of the terms used in the survey (i.e., automated communication systems, electronic health records, and virtual nurses) these terms were carefully defined in the instructions sections of the survey and examples were provided. To help communicate the concept of automated communication systems, the survey provided several examples, such as customer service lines: "A good example is a 1-800 customer service line. When you call a 1-800 customer service line you often talk to a machine that answers your questions. That machine is a type of automated communication system". The instructions also include the examples of ATMs and self-service checkouts at grocery stores. The instructions also tell participants that "In modern society, you encounter different types of automated communication all the time … When we say 'automated communications' in this study, we would like you to think of all of these things".

The definition provided for electronic health records was, "EHR systems store personal health information (for a hospital network or clinic) and they can send messages about appointments, tests, and other information from your healthcare provider". Likewise, the instructions asking participants about a virtual nurse included an image of a woman interacting with a virtual nurse programme and a written explanation. The explanation told participants that

> A virtual nurse is a computer programme that can do many of the basic jobs of a nurse. For example, a virtual nurse can help a patient check-in to the hospital, help a patient check-out, and check to see if they are doing okay. A virtual nurse can help you read forms, may speak multiple languages (e.g., English and Spanish), and repeat information as many times as you like.

2.1.3. Measures

2.1.3.1. Avoidance of automated communication. Because no pre-existing scale to assess AAC existed, the authors developed a new scale to assess individuals' feelings of utility, frustration, convenience, and anxiety in dealing with automated communication. A pool of 15 items was initially developed, and all items were assessed on a 7-point Likert scale (*strongly disagree* to *strongly agree*), with all items coded so that higher scores indicated greater avoidance, in line with related measures (Kang & Kim, 2009). Some sample items include, "I like the fact that automated communication systems are not in a hurry" and "I try to avoid automated communication systems". Psychometric analysis of the scale and all items are reported in the results section.

2.1.3.2. Comfort with technology. Rodriguez et al. (2008) Comfort with Technology scale is a 9-item scale measuring respondents' comfort levels performing a variety of computer-related tasks. Items were assessed on a 5-point scale (*extremely uncomfortable* to *extremely comfortable).* The scale was found to be reliable (α = .97, M = 3.79, SD = .72)

2.1.3.3. Perceptions of technology. Past research has found that several perceptual variables are significant predictors of intention to utilise various technologies, including perceived ease of use (α = .89, M = 4.86, SD = 1.19), perceived usefulness (α = .95, M = 3.94, SD = 1.61), personal innovativeness (α = .81, M = 4.17, SD = .93), and playfulness with technology (α = .94, M = 3.60, SD = 1.32) (Agarwal & Karahanna, 2000; Agarwal & Prasad, 1998; Davis, 1989). All measures were adapted to refer to automated communication, and in all cases measures were assessed on a 7-point Likert scale (*strongly disagree* to *strongly agree*).

2.1.3.4. Cognitive absorption. Agarwal and Karahanna's (2000) 20-item measure of Cognitive Absorption captures the extent to which individuals become deeply involved in their use of software. The scale is measured on a 7-point Likert scale (*strongly disagree* to *strongly agree*). The original measure specifically targeted use of "the Web", which was replaced by "automated communication" for the purposes of this study. The scale was found to be reliable (α = .85, M = 3.77, SD = .80).

2.1.3.5. Social anxiety/phobia. The Liebowitz Social Anxiety/Phobia scale (Liebowitz, 1987) consists of 48 items measured on a 4-point scale (*extremely uncomfortable* to *extremely comfortable*) that assess fear/anxiety and avoidance of a variety of social situations such as meeting strangers or eating in public places. The scale is constructed by totalling participant responses within each subscale, with higher scores indicating greater levels of anxiety. Both subscales were reliable in the present study: fear/anxiety subscale (α = .87, M = 39.88, SD = 8.88) and avoidance subscale (α = .89, M = 41.54, SD = 10.44).

2.1.3.6. Intention to use automated communication technologies. A 3-item Intention to Use ACTs scale was designed to assess whether individuals plan to utilise automated communication systems. The measure was based on Agarwal and Karahanna's (2000) 3-item intention to use the web instrument and is assessed on a 7-point Likert scale (*strongly disagree* to *strongly agree*). Items included, "I plan to use automated communication technologies in the future", "I intend to continue using automated communication technologies in the future", and "I expect my use of automated communication technologies to continue into the future" (α = .95, M = 4.76, SD = 1.50).

2.1.3.7. Comfort with EHR systems. The 6-item Comfort with EHR Systems scale was developed based on Rosenberg's (1956) Faith in People scale and used to examine whether individuals felt worried, insecure, or resistant to storing their personal health information in an electronic health records system (α = .80, M = 4.13, SD = 1.01). In addition to the scale, participants responded to six EHR scenarios that examined their comfort with various hypothetical situations (see Appendix A for the scenarios). In both cases, measures were assessed on a 7-point scale ranging from *extremely uncomfortable* to *extremely comfortable*.

2.2. Results

Approximately 2% of the data were missing and replaced using expectation maximisation (Schafer & Olsen, 1998). Based on inter-item correlations, 6 of the items (items 1, 2, 3, 10, 11, and 15) were poorly correlated with the group (inter-item correlations less than .50). Micceri (1989) observed that, when tested, most data-sets violate assumptions of multivariate normality. Fortunately, Micceri also argued that multivariate abnormality could often be corrected for or, for many analyses, simply ignored. Consistent with his arguments, seven items were significantly skewed and nine items were significantly kurtotic (see Table 1). As a set, the items exhibited significant multivariate abnormality, skewness = 50.42, Z-score = 9.93, p < .001, and kurtosis = 323.08, Z-score = 6.75, p < .001. In the current research, data abnormality is only of concern for the confirmatory factor analysis reported in Study 2 (more details are provided in that analysis).

2.2.1. Exploratory factor analysis

To explore the factor structure of the AAC items, principal axis analysis with direct oblimin rotation was utilised. The nine items with inter-item correlations greater than .50 were included in the model. Parallel analysis was used to estimate a priori thresholds for eigenvalues based on the number of items (9), sample size (153), and 1000 replications. In the past, researchers have used a rule of thumb (eigenvalues greater than 1.0) in this type of analysis, but parallel analysis provides a more rigorous cut-off point based on design (Patil, Singh, Mishra, & Donovan, 2008). Principal axis analysis revealed that only the first factor had an eigenvalue (4.84) greater than the parallel analysis cut-off point (1.39). The first factor explained 53.77% of the variance. All nine items had factor loadings greater than .56. Accordingly, all nine

Table 1. Summary statistics for AAC items – study 1.

	M (SD)	Skew	Kurtosis	Factor loadings
(1) It is often more efficient than face-to-face communication	4.40 (1.66)	−.32	−.77*	–
(2) AC systems typically have all the options a person might choose	4.99 (1.41)	−.42*	−.67*	–
(3) Unlike face-to-face communication, I know what to expect from an AC system	3.75 (1.54)	.36	−.60*	–
(4) I like the predictability of AC.#	4.23 (1.60)	−.02	−.75*	.64
(5) AC systems are often frustrating.#	5.27 (1.52)	−.78*	−.05	.71
(6) It is often annoying trying to interact with AC systems.#	5.29 (1.48)	−.82*	.12	.79
(7) I can never get the right information from AC systems.#	4.34 (1.44)	−.08	−.57	.74
(8) I try to "get to a person" as quickly as I can when confronted with an AC system.#	5.16 (1.68)	−.68*	−.38	.79
(9) I like the fact that AC systems are not in a hurry.#	4.38 (1.74)	−.05	−1.03*	.57
(10) It is helpful that AC systems are often available 24 h a day.	2.45 (1.41)	1.28*	1.41*	–
(11) AC systems can often find information faster than a live person can.	4.29 (1.63)	−.07	−.75*	–
(12) I try to avoid AC systems.#	4.37 (1.59)	−.03	−.75*	.75
(13) I prefer the personal touch of face-to-face communication.#	5.24 (1.31)	−.56*	−.28	.56
(14) It is easier to get what I want from a live person.#	5.41 (1.41)	−.86*	.34	.67
(15) I am concerned that AC systems could leak my personal information.	3.63 (1.64)	.24	−.84*	–

Notes: Means, standard deviations, skew, and kurtosis for AAC items. For means, all items have been coded so that higher scores indicate greater avoidance. Items used in the final 9-item scale are marked with an (#).
*p < .05.

items were retained and used to make an AAC index ($M = 4.85$, SD = 1.12, skew = −.39, kurtosis = −.01, range: 1.56 – 7.00; higher scores equate to more avoidance).

2.2.2. Convergent and divergent validity

A bivariate correlation matrix was constructed to examine the zero-order relationship between AAC and other measures. The AAC scale was significantly related to sex such that females exhibited greater avoidance (see Table 2). It was not significantly related to age, race, or comfort with technology. The latter supports the validity of the construct as it suggests AAC is not simply a measure of general comfort with technology. AAC was negatively related to all of the perceptions of technology measures as well as cognitive absorption. All of these measures were adapted to refer to automated communication technologies; therefore, it is logical that AAC would be negatively correlated with each modified scale (e.g., greater avoidance is related to decreased perceived ease of use). Moreover, consistent with the explication of the construct, AAC was negatively related to the avoidance subscale of the social phobia index and unrelated to the fear/anxiety subscale. In other words, participants more likely to avoid social situations (i.e., interactions with live people) were more likely to prefer automated communication (i.e., interactions with machines). This is a good indicator that AAC captures an avoidant, anxiety-based orientation towards ACTs that intentions to use ACTs does not, as the latter has no relationship with the avoidance dimension of social phobia. AAC was negatively related with intention to use ACTs, EHR comfort, and four of the EHR scenarios (2, 4, 5, and 6).

In addition to examining AAC's relationship with all of the other measures, it is important to consider how those other measures are related and whether the overall pattern of relationships supports AAC as a distinct construct. For example, only two measures are correlated with the avoidance dimension of social phobia: AAC and the fear dimension of social phobia. Perceptions of technology, cognitive absorption, intentions to use ACTs, EHR comfort, and the EHR scenarios are all unrelated to the avoidance dimension of social phobia. Not only does this support AAC as a measure of avoidance, but it also supports the divergence of AAC and the avoidance dimensions of social phobia as the former is related to almost all of the other technology perception/intention measures whereas the latter is related to none. AAC is a measure of avoidance, but avoidance of a particular form that is distinguishable from social avoidance in general.

2.2.3. Discriminant validity

Following the recommendations of Compeau and Higgins (1995), the Fornell-Larcker criterion (1981) was used to assess the discriminant validity of the AAC. The FornellLarcker criterion determines whether or not a latent variable accounts for more variance in its indicator variables than it shares with other latent variables (i.e., the other constructs) in the same model. It does so by calculating the average variance extracted (AVE) for each construct in the model and then comparing that with the squared correlations between the constructs. If the square root of the AVE is greater than the bivariate correlations, then discriminant validity has been established (Fornell & Larcker, 1981). SmartPLS software (Ringle, Wende, & Becker, 2015) was used to compute AVEs for AAC and cognitive absorption, comfort with technology, EHR comfort, ACT use intentions, perceived ease of use, playfulness, and usefulness. As seen in Table 3, the square root of the AVE is substantially larger than the absolute value of the correlations between it and the other constructs, demonstrating discriminant validity.

Recently, it has been suggested that a heterotrait-monotrait (HTMT) analysis is more sensitive to discriminant validity than either the FornellLarcker criterion or assessing cross-loadings (Henseler, Ringle, & Sarstedt, 2015). An HTMT analysis looks at the "heterotrait-monotrait (HTMT) ratio of indicator correlations, which is the average of the hetereotrait-heteromethod correlations … relative to the monotrait-heteromethod correlations..." (Henseler et al., 2015, p. 121). The most conservative criterion for determining whether or not an HTMT analysis demonstrates discriminant validity is if the value of the HTMT is less than .85, discriminant validity has been demonstrated (Henseler et al., 2015; Kline, 2011). Once again, the SmartPLS (Ringle et al., 2015) software was used to compute the HTMT values for AAC and cognitive absorption, comfort with technology, EHR comfort, ACT use intentions, perceived ease of use, playfulness, and usefulness. As can be seen in Table 4, all HTMT values are less than .85, confirming the discriminant validity assessment provided by the FornellLarcker criterion test.

2.2.4. ACT use and comfort

In addition to examining bivariate relationships, it is also valuable to examine the relationship between AAC, intentions to use ACTs, and EHR comfort when controlling for demographics (age, sex, race) and a known predictor of intention/comfort (comfort with technology). Partial correlations were calculated between the AAC scale and several ACT use/comfort measures controlling for age, sex, race, and comfort with technology. AAC was significantly related to intentions to use ACTs ($r = -.26$, $p = .002$), EHR comfort ($r = -.23$, $p = .005$), and scenarios 2 ($r = -.24$, $p = .004$), 4 ($r = -.29$, $p < .001$), and 5 ($r = -.19$, $p = .021$). Interestingly, AAC was not related to scenario 1 ($r = .01$, $p = .883$), 3 ($r = -.14$, $p = .098$), and 6 ($r = -.15$, $p = .076$). Thus, those with higher AAC were not comfortable with personalised emails/letters from their providers about recommended screening

Table 2. Correlation matrix – study 1.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
(1) AAC	–																		
(2) Age	.02	–																	
(3) Sex	.15	−.03	–																
(4) Race/ethnicity	.04	.00	−.02	–															
(5) Comfort w/technology	−.14	.03	−.02	.08	–														
(6) Ease of use	−.34*	.07	−.05	.04	−.07	–													
(7) Usefulness	−.44*	.01	−.16*	−.06	−.04	.49*	–												
(8) Innovativeness	−.27*	−.03	−.22*	.04	.05	.33*	.29*	–											
(9) Playfulness	−.28*	−.10	−.18*	.00	.02	.32*	.53*	.52*	–										
(10) Cognitive absorption	−.32*	−.12	−.08	−.02	.00	.39*	.55*	.38*	.70*	–									
(11) SP – fear	−.11	−.02	−.01	.11	−.10	.04	.11	.18*	.10	.13	–								
(12) SP – avoidance	−.19*	−.04	−.11	.15	−.11	.05	.16	.07	.09	.14	.79*	–							
(13) Behavioural intention	−.26*	.20*	−.12	−.09	.05	.42*	.46*	.23*	.40*	.40*	.00	.06	–						
(14) EHR comfort	−.25*	.03	−.01	.04	.27*	.02	.04	.09	.02	−.01	−.01	−.05	.17*	–					
(15) Scenario 1	−.01	.17*	−.10	.03	.15	−.01	.11	.12	−.07	−.05	.00	−.01	.14	.22*	–				
(16) Scenario 2	−.22*	.08	.06	.07	.09	.18*	.04	.14	.08	.18*	.05	.01	.17*	.20*	.25*	–			
(17) Scenario 3	−.15	−.07	.02	.10	.19*	.06	−.07	.15	.10	.01	.08	.07	.11	.26*	.28*	.53*	–		
(18) Scenario 4	−.27*	−.16*	.07	.03	−.01	.08	.10	.25*	.10	.12	.12	.06	.04	.10	.12	.30*	.37*	–	
(19) Scenario 5	−.21*	.02	−.08	.02	.17*	.22*	.09	.22*	.06	.06	.07	.05	.20*	.24*	.38*	.28*	.38*	.36*	–
(20) Scenario 6	−.17*	.04	−.06	−.02	.19*	.16	.05	.25*	.01	.03	−.05	−.07	.19*	.23*	.41*	.23*	.29*	.35*	.83*

Notes: Bivariate correlations among variables in Study 1. Higher AAC scores indicate greater avoidance. SP = Social Phobia.
*$p < .05$.

Table 3. FornellLarcker discriminant validity analysis.

	1	2	3	4	5	6	7	8
(1) AAC	.69							
(2) Cognitive absorption	−.45	.67						
(3) Comfort w/technology	−.13	−.04	.91					
(4) EHR comfort	−.25	.06	.28	.72				
(5) Behavioural intention	−.27	.44	.05	.23	.95			
(6) Ease of use	−.37	.49	−.08	.00	.41	.86		
(7) Playfulness	−.28	.72	.01	.06	.40	.34	.86	
(8) Usefulness	−.42	.65	−.05	.07	.46	.50	.53	.93

Notes: The square root of the AVEs is found in the shaded boxes along the diagonal. All other numbers are correlations.

Table 4. HeterotraitMonotrait (HTMT) discriminant validity results.

	1	2	3	4	5	6	7
(1) AAC							
(2) Cognitive absorption	.51						
(3) Comfort w/ technology	.17	.10					
(4) EHR comfort	.38	.17	.30				
(5) Intentions to use ACT	.29	.46	.06	.26			
(6) Ease of use	.38	.51	.10	.10	.46		
(7) Playfulness	.30	.74	.06	.15	.42	.34	
(8) Usefulness	.43	.68	.06	.10	.48	.53	.56

Notes: Scores lower than .85 represent discriminant validity. For example, the HTMT score between AAC and Cognitive Absorption is .51, well below .85.

tests (scenario 2) or medical tests (scenario 4), nor did they like a touch screen system that could summon a live nurse if needed (scenario 5). Alternatively, those with higher AAC were not avoidant of having their data used for research (scenario 1), provider emails/letters about screening tests if they could choose to not receive them (scenario 3), or touch screen interfaces if there was a live nurse nearby (scenario 6).

3. Study 2

In study 1, the AAC scale demonstrated strong internal reliability as well as convergent and divergent validity. From a psychometric standpoint, the results of study 1 provide a foundation for a follow-up study – specifically, a confirmatory factor analysis of the AAC scale within a more representative population. To that end, a second study was carried out with a sample of adults. AAC was only related to one demographic variable in study 1 (sex); however, college student samples exhibit less variance on several demographics (education, age) that could be meaningfully related to avoidance. For instance, it is logical that younger individuals might be less avoidant perhaps partially due to greater comfort or familiarity with technology. Study 2 also sought to examine whether AAC was related to other health care-focused automated communication devices. Notably, participants in the second study were queried about the virtual nurse to examine whether individuals with higher AAC were less willing to interact with an automated relational agent (Bickmore et al., 2009).

3.1. Method

3.1.1. Participants

Participants were recruited from seven shopping malls. Sixteen hundred adults were recruited and a subsample (N = 299) was randomly assigned to the current study. Participants completed pen and paper surveys. Members of the research team provided participants with assistance by request or if a participant seemed to be struggling with questions. A few participants (n = 32) required some or all of the survey to be read to them due to literacy issues or physical limitations (e.g., poor eyesight). Participants were given a $10 gift card for completing the survey. All research procedures were approved and oversaw by an institutional research board.

More females (60.2%) participated than males (38.5%). Participants ranged from 18 – 90 years of age, with a mean age of 30.98 years (SD = 12.18). Given the increasing ubiquity of automated health systems and the fact that older patients have a much higher rate of health care visits (doctor's offices, emergency departments, hospital visits, and home visits; National Center for Health Statistics, 2016) than younger patients, they are more likely to come into contact with automated health systems. As such, it may also be helpful to note that 19.5% of the sample was over age 40. The participants were predominantly Caucasian: 79.3% Caucasian, 13.0% African-American, 2.0% Hispanic, Latino, or Spanish Origin, 4.3% Asian or Pacific Islander, 1.3% American Indian or Native American, and 2.3% described themselves as "other" (participants could check more than one category). Education was distributed as follows: less than a high school degree (3.3%), high school degree (22.1%), one year of college/vocational training (28.8%), 2–3 years of college/vocational training (28.4%), 4 year college graduate (16.1%), and 4 missing data. Most participants owned a computer (93.3%) and had access to high-speed internet (88.3%).

3.1.2. Measures

In addition to the AAC, participants in study 2 completed several measures identical to those used in study 1 including behavioural intention to use automated communication (α = .92, M = 4.32, SD = 1.72), comfort with EHR (α = .85, M = 4.05, SD = 1.43), and comfort with technology (α = .96, *M* = 3.64, SD = .73). Participants also completed an 8-item scale measuring comfort with the virtual nurse (α = .91, *M* = 2.46, SD = .91) and a 4-item scale measuring attitude towards the virtual nurse (α = .78, *M* = 2.97, SD = .97). In both cases, responses were assessed on a 5-point Likert scale ranging from *strongly disagree* to *strongly agree*. Finally, since health literacy has proven to be a significant variable in health communication research, a single-item measure of health literacy (5-point scale, *strongly disagree* to *strongly agree*) was included in the protocol (Morris, MacLean, Chew, & Littenberg, 2006; *M* = 1.90, SD = 1.02).

3.2. Results

Approximately 3% of the data were missing and replaced using expectation maximisation (Schafer & Olsen, 1998). As a set, the items exhibited significant multivariate abnormality, skewness = 14.81, *Z*-score = 15.76, $p < .001$, and kurtosis = 154.26, Z-score = 10.99, $p < .001$ (see Table 5).

3.2.1. Confirmatory factor analysis

The nine-item AAC scale identified in study 1 was subjected to confirmatory factor analysis (CFA). The basic measurement model consisted of one latent variable (AAC) and nine indicators. Model estimation was carried out using Lisrel 8.8. Because the data were non-normal, CFA was carried out using the asymptotic covariance matrix. Thus, a SatorraBentler (S-B) χ^2 is reported, which adjusts for non-normal distributions (see Satorra & Bentler, 2010). In addition to the S-B χ^2, which can be sensitive to sample size, five other fit indices were examined: χ^2/df ratio, CFI, RMSEA, SRMR, and Model AIC. The χ^2/df ratio adjusts for sample size by dividing the χ^2 by the degrees of freedom. Ratios below three indicate a good fit to the data (Kline, 2011). For CFI, conventional standards suggest .95 or higher to indicate good fit (Hu & Bentler, 1999). For RMSEA, .08 and lower indicate good fit (Holbert & Stephenson, 2008; Hu & Bentler, 1999). The Standardised RMR (SRMR) indicates good fit at .08 or lower (Hu & Bentler, 1999). The Model AIC is used to compare different models; lower scores indicate better fit (Akaike, 1987).

The initial 9-item model was not a good fit for the data, S-B χ^2 (27, N = 299) = 176.92, $p < .001$, χ^2/df ratio = 6.55, CFI = .91, RMSEA = .14 (90% CI: .12, .16), SRMR = .10, Model AIC = 212.92. An examination of the modification indices revealed that model fit would be significantly enhanced by allowing error-term correlations for AAC5 and AAC6, AAC4 and AAC9, and AAC13 and AAC14. Bentler (2010) noted that correlated error-terms should be explained, though he also argued that they may be unavoidable. In this case, the correlation is logical for AAC5 and AAC6 as the items contain similar language (e.g., "often frustrating" and "often annoying") which likely led to spurious correlations independent of the latent construct. Likewise, AAC4 and AAC9 both begin with the same clause, "I like" which likely triggers spurious correlation. The same is true of AAC13 and AAC14 which both refer to interacting with a live person. A revised model was tested allowing for an error-term correlation between AAC5 and AAC6, AAC4 and AAC9, and AAC13 and AAC14. The revised model was an excellent fit for the data, S-B χ^2 (24, *N* = 299) = 33.62, *p* = .09, χ^2/df ratio = 1.40, CFI = .99, RMSEA = .04 (90% CI: .00, .06), SRMR = .04, Model AIC = 75.62 (see Figure 1). Again, the final 9-item AAC proved to be highly reliable (*M* = 5.06, SD = 1.15, α = .83, skewness = −.28, kurtosis = −.69).

Table 5. Summary statistics for AAC items – study 2.

	M (SD)	Skew	Kurtosis
(1) It is often more efficient than face-to-face communication	3.59 (1.99)	.36*	−1.12*
(2) AC systems typically have all the options a person might choose	2.95 (1.50)	.45*	−.49*
(3) Unlike face-to-face communication, I know what to expect from an AC system	3.80 (1.79)	.08	−.98*
(4) I like the predictability of AC#	3.55 (1.85)	.22	−1.03*
(5) AC systems are often frustrating#	2.63 (1.77)	.97*	−.07
(6) It is often annoying trying to interact with AC systems#	2.66 (1.81)	1.02*	.06
(7) I can never get the right information from AC systems#	3.71 (1.66)	.11	−.63*
(8) I try to "get to a person" as quickly as I can when confronted with an AC system#	2.58 (1.87)	.96*	−.30
(9) I like the fact that AC systems are not in a hurry#	3.42 (1.83)	.31*	−.87*
(10) It is helpful that AC systems are often available 24 h a day	5.69 (1.42)	−.05*	.62
(11) AC systems can often find information faster than a live person can	3.64 (1.83)	.15	−.94*
(12) I try to avoid AC systems#	3.25 (1.92)	.41*	−1.02*
(13) I prefer the personal touch of face-to-face communication#	2.37 (1.45)	.88*	−.19
(14) It is easier to get what I want from a live person#	2.27 (1.35)	.95*	.32
(15) I am concerned that AC systems could leak my personal information	3.80 (2.02)	.10	−1.26*

Notes: Means, standard deviations, skew, and kurtosis for AAC items. For means, all items have been coded so that higher scores indicate greater avoidance. Items used in the final 9-item scale are marked with an (#).
*$p < .05$.

3.2.2. Convergent and divergent validity

The AAC scale was positively related to age, with older individuals expressing greater avoidance (see Table 6). The AAC scale was unrelated to sex, race, income, education, having high-speed Internet, computer comfort, or health literacy.

3.2.3. ACT use and comfort

Partial correlations were calculated between the AAC scale and several ACT use/comfort measures (controlling for age, sex, race, and computer comfort). AAC was significantly related to intentions to use ACTs ($r = -.57$, $p < .001$), EHR comfort ($r = -.42$, $p < .001$),

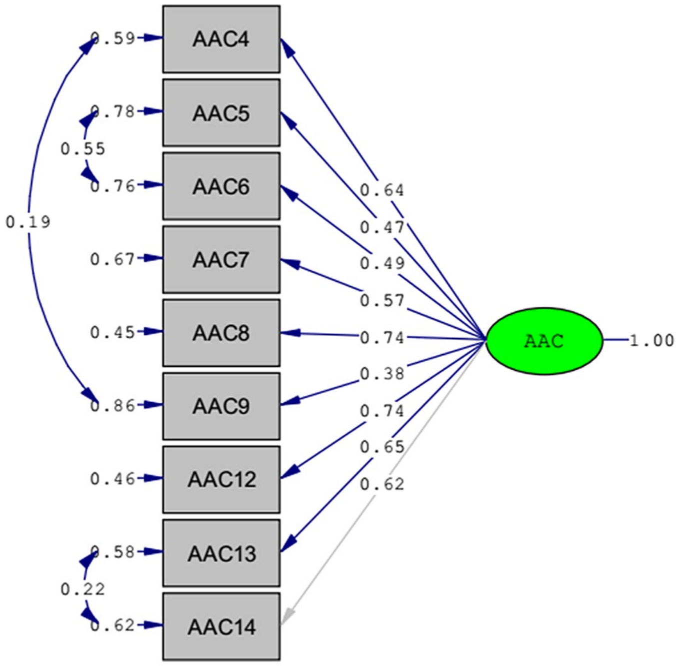

Figure 1. Confirmatory factor analysis of the study 2 AAC scale. Item 1 in the CFA corresponds to item 1 in Table 1.

Table 6. Correlation matrix – study 2.

	1	2	3	4	5	6	7	8	9	10	11	12
(1) AAC	–											
(2) Age	.12*	–										
(3) Sex	−.02	.11	–									
(4) Race/ethnicity	.00	.10	.00	–								
(5) Income	−.07	.27*	.06	.21*	–							
(6) Education	.02	.24*	.04	−.14*	.12	–						
(7) Have high speed Internet	−.07	−.12*	.02	−.08	.07	.18*	–					
(8) Computer comfort	−.08	−.17*	−.07	−.03	−.07	.10	.09	–				
(9) Health literacy	.01	−.20*	.01	−.04	−.13	−.19*	.00	.00	–			
(10) Behavioural intentions	−.56*	−.02	.04	.09	.15*	.08	.11	.04	−.11	–		
(11) EHR comfort	−.43*	−.10	−.07	.06	.10	.09	.05	.17*	−.08	.35*	–	
(12) Virtual nurse – attitude	−.31*	.09	−.01	−.02	.01	.14*	.08	.16*	−.07	.26*	.39*	–
(13) Virtual nurse – comfort	−.32*	−.06	−.09	−.06	−.07	.05	.11	.14*	−.02	.26*	.43*	.70*

Notes: Bivariate correlations among variables in Study 2. Higher AAC scores indicate greater avoidance.
*$p < .05$.

comfort with the virtual nurse ($r = -.31$, $p < .001$), and attitudes towards the virtual nurse ($r = -.33$, $p < .001$). Although the correlation between AAC and intentions to use ACTs was fairly high ($r = -.60$), MacKenzie et al. (2011) argue that correlations below $r = .71$ tend to indicate discriminant validity between the constructs, given that a correlation of .71 indicates that the constructs share less than half of their variance. In this case, AAC and intentions to use ACT are conceptually connected (as would be expected), but do not share enough variance to support the argument that they are measures of the same construct.

4. Discussion

The present study developed and validated the AAC scale. Older individuals were more likely to avoid automated communication (study 2) whereas avoidance-oriented individuals with social phobia were found to favour automated communication (study 1). Consistent with the logic of the construct, less avoidant individuals were more interested in and comfortable with automated communication, including EHRs and virtual nurses.

Future research with the AAC scale should examine whether certain features of automated interfaces trigger avoidance. There are several promising features to explore as AAC research advances. It has been argued that Microsoft's Clippy failed primarily because it frequently interrupted users with non-relevant queries and information, a behaviour that was perceived as impolite (Whitworth, 2005). Decreasing avoidant behaviour may require the reconfiguration of ACTs within a more human-centred framework that considers the ramifications and interactions between users, organisations, and communication interfaces (Maglio, Kwan, & Spohrer). Relatedly, Dey (2009) noted that many adaptive applications are rejected by users because they lack sufficient intelligibility – that is, users are unable to understand how and why the technology responds in a given situation. Intelligibility, a form of interface transparency, encourages user trust in the application and allows users to better navigate and self-correct. ACTs that act without cause or encumber users during interaction will likely dissuade avoidant populations and perhaps, as with politeness, cultivate greater avoidance among dissatisfied users. Older individuals, on the other hand, may favour larger interfaces that don't rely heavily on numerical information (Jensen et al., 2010). Given the relationship between AAC and age, identifying features that reduce avoidance and encourage diffusion within older populations should be an objective of health information systems research. This is especially important given that the majority of consumers of EHRs and other health systems ACTs are older adults (National Center for Health Statistics, 2016). Even outside of the health context, ACTs are becoming more and more ubiquitous and the population of the US – as well as several other nations – is ageing rapidly. In order to ensure that this population is well-served, the interconnections between AAC and age should continue to be examined.

The current study suggests that ACTs could be particularly valuable for individuals with social phobia. In study 1, individuals with social phobia exhibited lower AAC, a finding that is consistent with the explication of both constructs. Past research parallels this finding as teens with social phobia have self-reported greater use of technologies – online chatting and cell phone texting – that allow for less face-to-face interaction (Pierce, 2009).

In line with this idea, people with high social phobia may prefer interfaces that allow them to disclose personal information without human-to-human interaction. In one study (Kang & Gratch, 2010), participants disclosed a greater amount of more intimate information to a virtual avatar than a webcam video of a real human. If this holds true for ACT contexts, then relational agents, like the virtual nurse, could be effective at reaching socially phobic populations, although researchers should test the assumption that more lifelike computer interfaces are preferred by this subgroup.

It is possible that as relational agents become more lifelike they will cultivate avoidance in individuals with social phobia, especially as interactive programmes gain the ability to read and react to non-verbal information (Bickmore et al., 2010; Gamble & Rapee, 2010). Individuals with social phobia are sensitive to monitoring and often (incorrectly) perceive that their non-verbal behaviour is incorrect or inadequate (Rapee & Heimberg, 1997). This is well illustrated by a study Kang, Gratch, Wang, and Watt (2008) conducted that found that when socially anxious participants were faced with an avatar whose non-verbal responses did not match the speaker's words they were both more embarrassed and rated their self-performance more poorly than when they interacted with avatars whose non-verbal signals were in sync with the speaker's words. This suggests that the quality of non-verbal feedback that automated agents provide will likely have a significant impact on the efficacy of relational agents for reaching socially phobic populations. Relational agents aside, researchers should consider the possibility that individuals with social phobia will be less avoidant, and more effective, when using ACTs that exhibit clear structure. Individuals with social phobia have performed better in social situations with clearly defined structure (Rapee & Heimberg, 1997).

Ultimately, a key aspect of the work going forward is identifying how individuals high and low in AAC react to different ACT features. It is possible, for example, that features of ACT that appeal to people in general will have no impact on individuals with high AAC, or even a negative impact. For example, research on interactive interfaces has suggested that for the vast majority of individuals, a system that is able to recall previous inputs and use them in guiding future interactions (sometimes referred to as "contingency") is a highly attractive feature (Sundar, Jia, Waddell, & Huang, 2015). However, for individuals with high AAC, this responsiveness and storing of information may be off-putting, given that it would increase variability in the system response and reduce the reliability of the interaction, features that those high in AAC find to be irritating.

Conversely, features that are meaningless to most might be highly attractive to those with high levels of AAC. For example, one of the primary factors in AAC is that people high in AAC find ACTs to be frustrating or annoying. A possible way around this issue would be to increase the politeness of the language used in ACT systems (e.g., "Would you please enter your date of birth?" as opposed to "Enter your date of birth."). Research has shown that when automated systems display politeness, there is a reciprocity effect, with the users showing greater tolerance and increased positive evaluations of the system (Hoffmann, Kramer, Lam-chi, & Kopp, 2009; Nass, Moon, & Carney, 1997; Reeves & Nass, 1996). Although most users may not care whether or not the system is "polite" (instead appreciating its utility), those high in AAC may be strongly effected by a small change in wording.

Currently, advances in ACTs are being driven by the structural needs of organisations, technological innovation, and the perceptions of designers and professionals, with a general emphasis placed on product usability. However, it cannot be assumed that simply improving the quality of AACs will benefit the entire population. This study found that social phobics actually have an attraction towards ACTs, and it is possible that other populations that often face difficulty with face to face interactions (e.g., autistic people) may also prefer to engage with ACTs at their current level of technical refinement. Future research should push to examine the exact impact of varying features in ACTs, including the presence and absence of embodied agents and the realism of their responses and actions.

Additionally, researchers should continue to examine the psychometric properties of the AAC scale. Establishing predictive validity with use of ACTs is a priority as is research examining the stability of the scale overtime (i.e., test-retest reliability). A longitudinal study tracking use of ACTs and AAC at multiple points in time could serve both ends. Researchers looking to use the AAC as a diagnostic tool in technology development might benefit from a state-based version of the measure as that would enable immediate feedback on how specific features trigger avoidance. A state-based measure would also enable researchers to examine the relationship between state and dispositional AAC; a research programme that could identify when and how AAC develops over time. Such a research programme would intersect with research on the development of social phobia (Gazelle & Rubin, 2010). Finally, work investigating the relationship among communication avoidance, apprehension, and AAC would help to explicate the construct and its foundations.

4.1. Limitations

Study 1 utilised a college student sample which may limit the generalisability of the results. Study 2 was carried out with adults, but participants were recruited from seven malls in Indiana and thus it is best described as a convenience sample. Though more representative than study 1, the demographics of participants in study 2 do not perfectly conform to that of the US. Both studies were survey-based and some questions focused on intentions concerning emerging ACTs. As a result, it is not possible to extrapolate causality or prediction of actual behaviour from these data.

5. Conclusion

ACTs are increasing at a dramatic rate. Several innovative devices in health care, for example, employ automated communication interfaces. Understanding how key segments of the population perceive these technologies is a vital step towards successful development and implementation. The AAC scale is a new tool that will help researchers identify populations that may be at high risk for rejecting ACTs, develop technologies that are less prone to trigger avoidance, and theorise AAC in models of ACT adoption.

Acknowledgements

Katheryn R. Christy is a post-doctoral research associate in the Department of Communication at the University of Utah. Jakob D. Jensen (PhD, University of Illinois, 2007) is an associate professor in the Department of Communication and the Department of Health Promotion and Education at the University of Utah. Brian Britt is an assistant professor in the Department of Communication at South Dakota State University. Courtney L. Scherr is an assistant professor in the School of Communication at Northwestern University. Christina Jones is an assistant professor in the Department of Communication at the Ball State University. Natasha R. Brown is an assistant professor in the Department of Communication at Indiana University – Northwest. None of the authors have any financial interest or benefit arising from the direction application of this research.

Funding

This research was supported, in part, by an R25 grant from the National Cancer Institute [grant number R25 CA 090314].

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix A. EHR scenarios

How comfortable are you with the following scenarios:

Scenario #1:

Your health care system allows researchers to use health information from their EHR database to advance understanding of health. The health information is stripped of all identifying information (names, ID numbers, home towns) before the researchers are given access to it.

Scenario #2:

Your health care system uses an EHR system to send you personalised emails and/or letters that provide you with information about recommended screening tests (e.g., colonoscopies).

Scenario #3:

Your health care system uses an EHR system to send you personalised emails and/or letters that provide you with information about recommended screening tests (e.g., colonoscopies). However, you only receive the messages if you request to receive them.

Scenario #4:

Your health care provider uses an EHR system to send you personalised emails and/or letters that tell you the results of your medical tests.

Scenario #5:

Instead of filling out a pen-and-paper form, your health care system has you register for an appointment using a touch screen computer in the lobby of the hospital or clinic. If you need a live person for help, you can press a button on the screen to summon a nurse.

Scenario #6:

Instead of filling out a pen-and-paper form, your health care system has you register for an appointment using a touch screen computer in the lobby of the hospital or clinic. If you need a live person for help, there is a nurse sitting nearby for assistance.