The Elements of Computer Credibility

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ABSTRACT
Given the importance of credibility in computing products, the research on computer credibility is relatively small. To enhance knowledge about computers and credibility, we define key terms relating to computer credibility, synthesize the literature in this domain, and propose three new conceptual frameworks for better understanding the elements of computer credibility. To promote further research, we then offer two perspectives on what computer users evaluate when assessing credibility. We conclude by presenting a set of credibility-related terms that can serve in future research and evaluation endeavors.

Keywords
credibility, trustworthiness, expertise, persuasion, captology, trust, influence, information quality, psychology of HCI

INTRODUCTION
Like many aspects of our society, credibility is becoming increasingly important for computer products. In the not-too-distant past, computers were perceived by the general public as virtually infallible [31, 39]. Today, the assumption that computers are credible seems to be eroding. As a community of HCI professionals, we should be concerned about the credibility of the computer products we create, research, and evaluate. But just what is *credibility*? And what makes *computers* credible?

This paper addresses these and other issues about computer credibility. In doing so, we don't suggest easy answers; we certainly don't offer a "how to" checklist for credible computer products. Instead, this paper (1) outlines key terms and concepts that relate to credibility, (2) synthesizes the existing literature on computer credibility, (3) provides new conceptual frameworks for understanding computer credibility, and (4) suggests approaches for further addressing computer credibility in research, evaluation, and design efforts. By doing these things, this paper can serve as a key step toward more credible computer products—that is, more credible desktop applications, web sites, specialized computing devices, and so on.

WHAT IS "CREDIBILITY"?
What is "credibility"? Simply put, *credibility* can be defined as *believability*. Credible people are believable people; credible information is believable information. In fact, some languages use the same word for these two English terms. Throughout our research we have found that *believability* is a good synonym for *credibility* in virtually all cases. The academic literature on credibility, which dates back to the 1930s (see [32, 38] for a review), presents a more sophisticated view of credibility, although the essential meaning is similar to what we propose. Virtually all credibility scholars describe credibility as—

- a perceived quality
- made up of multiple dimensions [3, 9, 32, 38, 40]

First, credibility is a perceived quality; it doesn't reside in an object, a person, or a piece of information. Therefore, in discussing the credibility of a computer product, one is always discussing the *perception* of credibility.

Next, scholars agree that credibility perceptions result from evaluating multiple dimensions simultaneously. Although the literature varies on how many dimensions contribute to credibility evaluations, the vast majority of researchers identify two key components of credibility:

- trustworthiness
- expertise

What this means is that in evaluating credibility, a person makes an assessment of both trustworthiness and expertise to arrive at an overall credibility assessment.

Trustworthiness, a key element in the credibility calculus, is defined by the terms *well-intentioned*, *truthful*, *unbiased*, and so on. The trustworthiness dimension of credibility captures the perceived goodness or morality of the source. Rhetoricians in ancient Greece used the terms *ethos* to describe this concept.

Expertise, the other dimension of credibility, is defined by terms such as *knowledgeable*, *experienced*, *competent*, and so on. The expertise dimension of credibility captures the perceived knowledge and skill of the source.

Taken together, these ideas suggest that *highly credible computer products will be perceived to have high levels of both trustworthiness and expertise.*

Semantic problems in discussing credibility
Unfortunately, English seems to be a difficult language for discussing credibility. Often in the academic literature—both in psychology and in HCI—writers have used the terms

credibility and *trust* imprecisely and inconsistently. We hope the following paragraphs can help clarify the semantic issues.

First of all, *trust* and *credibility* are not the same concept. Although these two terms are related, *trust* and *credibility* are not synonyms. *Trust* indicates a positive belief about the perceived reliability of, dependability of, and confidence in a person, object, or process [36, 37]. For example, users may have trust in a computer system designed to keep financial transactions secure. We suggest that one way to interpret the word *trust* in HCI literature is to mentally replace it with the word *dependability*. One helpful (though simplistic) summary is as follows:

- *credibility* → "believability"
- *trust*→ "dependability"

The semantic issues get slightly more complicated. A number of studies use phrases such as "trust in the information" and "trust in the advice" (e.g., see [13, 27]). We propose that these phrases are essentially synonyms for credibility; they refer to the same psychological construct. Table 1 shows some of the most common phrases in HCI research that refer to credibility:

Various phrases refer to credibility
• "trust the information"
• "accept the advice"
• "believe the output"

Table 1: Various phrases describe the credibility construct.

As a result of these semantic issues, those who read the research on trust and machines must note if the author is addressing "trust"—*dependability*—or if the author is addressing "trust in information"—*credibility*. We suspect that the confusing use of these English terms has impeded the progress in understanding credibility as it applies to computer products.

WHEN DOES CREDIBILITY MATTER IN HCI?

Now that we have defined key terms relating to credibility, we next outline when credibility matters in human-computer interactions. Quite frankly, in some cases computer credibility does not seem to matter—such as when the computer device is invisible (in automobile fuel-injection systems, for example) or when the possibility of bias or incompetence is not apparent to users (such as in using a pocket calculator). However, in many situations computer credibility matters a great deal. We propose that credibility matters when computer products—

- act as knowledge sources
- instruct or tutor users
- act as decision aids
- report measurements
- run simulations
- render virtual environments
- report on work performed
- report about their own state

The above eight categories are not exhaustive; we anticipate that future work on computer credibility will add to and refine our categories. Furthermore, these categories are not mutually exclusive; a complex computer system, such as an aviation navigation system, might incorporate elements from many categories: presenting information about weather conditions, measuring airspeed, rendering a visual simulation, and reporting the state of the onboard computer system. Many, but not all, of the above eight categories have been the focus of research on computers and credibility, as synthesized in the following section.

HCI RESEARCH ON CREDIBILITY

Given the wide applicability of credibility in computing, a relatively small body of research addresses perceptions of credibility in human-computer interactions. What follows is our synthesis of the previous research, clustered into six domains.

#1: The credible computer myth

One cluster of research investigates the idea that people automatically assume computers are credible. In framing these studies, the authors state that people perceive computers as "magical" [2], with an "'aura' of objectivity" [1], as having a "scientific mystique" [1], as "awesome thinking machines" [31], as "infallible" [14], as having "superior wisdom" [39], and as "faultless" [39]. In sum, researchers have long suggested that people generally are in "awe" of computers [12] and that people "assign more credibility" to computers than to humans [1].

But what does the empirical research show? The studies that directly examine assumptions about computer credibility conclude that—

- Computers are <u>not</u> perceived as more credible than human experts [1, 12, 22, 31].
- In some cases computers may perceived as <u>less</u> credible [19, 41].

Although intuition suggests that people may perceive computers as more credible than humans in some situations, no solid empirical evidence supports this notion.

#2: Dynamics of computer credibility

Another cluster of research examines the dynamics of computer credibility—how it is gained, how it is lost, and how it can be regained. Some studies demonstrate what is highly intuitive: Computers gain credibility when they provide information that users find accurate or correct [10, 13, 27]; conversely, computers lose credibility when they provide information users find erroneous [13, 17, 27]. Although these conclusions seem obvious, we find this research valuable because it represents the first empirical evidence for these ideas. Other findings on the dynamics of credibility are less obvious, which we summarize in the following paragraphs.

The effects of computer errors on credibility

A few studies have investigated the effects of computer errors on perceptions of computer credibility. Although researchers acknowledge that a single error may severely damage computer credibility in certain situations [13], no study has clearly documented this effect. In fact, in one study, error rates as high as 30% did not cause users to dismiss an onboard automobile navigation system [10, 13]. To be sure, in other contexts, such as getting information from an automated teller machine, a similar error rate would likely cause users to reject the technology completely.

The impact of small errors

Another research area has been the effects of large and small areas on credibility. Virtually all researchers agree that computer errors damage credibility—at least to some extent. One study demonstrated that large errors hurt credibility perceptions more than small errors but not in proportion to the gravity of the error [17, 18]. Another study showed no difference between the effects of large and small mistakes on credibility [13]. Findings from these studies and other work [27] suggest that—

- Small computer errors have disproportionately large effects on perceptions of credibility.

Two paths to regaining credibility

Researchers have also examined how computer products can regain credibility [18]. Two paths are documented in the literature:

- The computer product regains credibility by providing good information over a period of time [10, 13].
- The computer product regains some credibility by continuing to make the identical error; users then learn to anticipate and compensate for the persistent error [27].

In either case, regaining credibility is difficult, especially from a practical standpoint. Once users perceive that a computer product lacks credibility, they are likely to stop using it, which provides no opportunity for the product to regain credibility [27].

#3: Situational factors that affect credibility

The credibility of a computer product does not always depend on the computer product itself. Context of computer use can affect credibility. The existing research shows that three related situations increase computer credibility:

- In unfamiliar situations people give more credence to a computer product that orients them [25].
- Computer products have more credibility after people have failed to solve a problem on their own [42].
- Computer products seem more credible when people have a strong need for information [10, 13].

Indeed, other situations are likely to affect the perception of computer credibility, such as situations with varying levels of risk, situations with forced choices, and situations with different levels of cognitive load. However, research is lacking on these points.

#4: User variables that affect credibility

Although individual differences among users likely affect perceptions of computer credibility in many ways, the extant research allows us to draw only two general conclusions:

User familiarity with subject matter

First, users who are familiar with the content (e.g., an experienced surgeon using a computer simulation of surgery) will evaluate the computer product more stringently and likely perceive the computer product to be less credible [12, 13, 19]. Conversely, those not familiar with the subject matter are more likely to view the computer product as more credible [41, 42]. These findings agree with credibility research outside of HCI [9, 38, 43].

User understanding of computer system

Next, researchers have investigated how user acceptance of computer advice changes when users understand how the computer arrives at its conclusions. One study showed that knowing more about the computer actually *reduced* users' perception of computer credibility [2]. However, other researchers have shown the opposite: Users were more inclined to view a computer as credible when they understood how it worked [17, 19, 23, 25]. In this line of research users either learned about the computer product before using it [25, 42], or the computer justified its decisions in real time through dialog boxes [23].

#5: Visual design and credibility

Another line of research has investigated the effects of interface design on computer credibility [15]. These experiments have shown that—at least in laboratory settings—certain interface design features, such as cool color tones and balanced layout, can enhance users' perceptions of interface trustworthiness. Although these design implications may differ according to users, cultures, and target applications, this research sets an important precedent in studying the effects of interface design elements on perceptions of trustworthiness and credibility.

#6: *Human credibility markers in HCI research*

An additional research strategy has been investigating how credibility findings from human-human interactions apply to human-computer interactions. Various researchers have advocated this approach [7, 15, 25, 34, 35]. The following paragraphs explain key findings using this research strategy, while the final paragraph in this section outlines additional possibilities.

Common affiliation leads to credibility

Psychology research shows that in most situations people find members of their "in-groups" (those from the same company, the same team, etc.) to be more credible than people who belong to "out-groups" [21]. Researchers demonstrated that this dynamic also held true when people interacted with a computer they believed to be a member of their "in-group" [28]. Specifically, users reported the "in-group" computer's information to be of higher quality, and users were more likely to follow the computer's advice.

Similarity leads to credibility

Psychology research has shown that we perceive people who are similar to us as credible sources [4, 6, 44]. One type of similarity is geographical proximity. In researching this phenomenon in HCI, an experiment showed that computer users perceived information from a proximal computer to be more credible than information from a distal computer [24]. Specifically, users adopted the proximal computer's information more readily, and they perceived the information to be of higher quality.

Labels of expertise give more credibility

Titles that denote expertise (e.g., *Dr.*, *Professor*, etc.) make people seem more credible [6]. Applying this phenomenon to the world of technology, researchers labeled a technology as a specialist. This study showed that people perceived the device labeled as a specialist to be more credible than the device labeled as a generalist [29, 35].

Additional H-H dynamics in HCI

In addition to the above three lines of research, other human-human credibility dynamics are likely to apply to HCI. Outlined elsewhere [7], the possibilities include the following principles to increase computer credibility:

- Physical attractiveness [5] - Making the computing device or interface attractive.
- Association [6] - Associating the computer with desirable things or people.
- Authority [9, 44] - Establishing the computer as an authority figure.
- Source diversification [9, 11] - Using a variety of computers to offer the same information.
- Nonverbal cues [16] - Endowing computer agents with nonverbal markers of credibility.
- Familiarity [9, 38, 43] - Increasing the familiarity of computer products.
- Social status [6] - Increasing the status of a computer product.

Researchers have yet to specifically show how the above principles—which are powerful credibility enhancers in human-human interactions—might be implemented in computing systems [8].

THREE NEW VIEWS OF CREDIBILITY

So far, our paper has defined key terms and reviewed the relevant research on computers and credibility. We now change focus somewhat. In this next section we offer three new conceptual frameworks for viewing computer credibility. They are (1) the four types of credibility, (2) the two credibility evaluation errors, and (3) the three strategies for evaluating credibility. We believe that having new ways to think about—and a greater vocabulary for—computer credibility will enhance our HCI community's ability to research, evaluate, and design credible computers.

Four types of credibility

The first conceptual framework we propose outlines four different types of computer credibility. The overall assessment of computer credibility may rely on aspects of each of these four types simultaneously.

Presumed credibility

Presumed credibility describes how much the perceiver believes someone or something because of *general assumptions* in the perceiver's mind. For example, people presume that most people tell the truth, but we also presume car salespeople may not be totally honest. Presumed credibility relies on the assumptions and stereotypes of our culture. Assumptions and stereotypes also exist for computers [41]. In general, people presume computers have expertise and are trustworthy (they are "basically good and decent" [25]).

Reputed credibility

The next type of credibility, *reputed* credibility, describes how much the perceiver believes someone or something because of what *third parties have reported.* This applies very much to computer technologies. For example, a nonprofit consumer magazine may run tests that show Company XYZ makes highly accurate tax software. This third-party report would give Company XYZ's computer products a high level of reputed credibility.

Surface credibility

The third type of credibility is *surface* credibility, which describes how much a perceiver believes someone or something based on *simple inspection.* (In other words, with surface credibility people *do* judge a book by its cover.) For example, a web page may appear credible just because of its visual design [15]. Or the solid feel of a handheld computing device can make users perceive it as credible.

Experienced credibility

The last type of credibility is *experienced* credibility. This refers to how much a person believes someone or something based on *first-hand experience.* For example, over a period of time a fitness enthusiast may determine that her computerized heart rate monitor is highly accurate.

Two credibility evaluation errors

For each type of credibility listed above, computer users can make various types of evaluations [17, 25, 39]. Some of these evaluations are appropriate, while others are erroneous. Table 2 shows four possible evaluation options:

	User perceives product as credible	User perceives product as not credible
Product is credible	appropriate acceptance	**Incredulity Error**
Product is not credible	**Gullibility Error**	appropriate rejection

Table 2: Four evaluations of credibility

The most notable aspects of this conceptual framework are the two errors. The first type of error is what we call the "Gullibility Error." In this error, even though a computer product (such as a web page) is not credible, users perceive the product to be credible. Various individuals and institutions, especially those in education, have taken on the task of teaching people to avoid the Gullibility Error. Often this is under the heading of "information quality." (For example, see www.vuw.ac.nz/~agsmith/evaln/evaln.htm.)

The second type of error is what we call the "Incredulity Error." In this error, even though a computer is credible, users perceive the product to be not credible. Of the two types of errors, the Incredulity Error is likely to be of greater concern to those of us who design, research, and evaluate computer products. In general, reducing the Incredulity Error without increasing the Gullibility Error should be a goal of HCI professionals.

Three models of credibility evaluation

The conceptual framework in Table 2 outlines two types of evaluation errors, but it doesn't account for different evaluation strategies people might use for assessing credibility. For most people, evaluations of credibility are not simply accept or reject decisions, as Table 2 may imply. Adapting previous work [32, 33], we now propose three prototypical models for evaluating computer credibility: Binary Evaluation, Threshold Evaluation, and Spectral Evaluation. Figure A illustrates these three models by making the level of user acceptance a function of the theoretical credibility of the computer product.

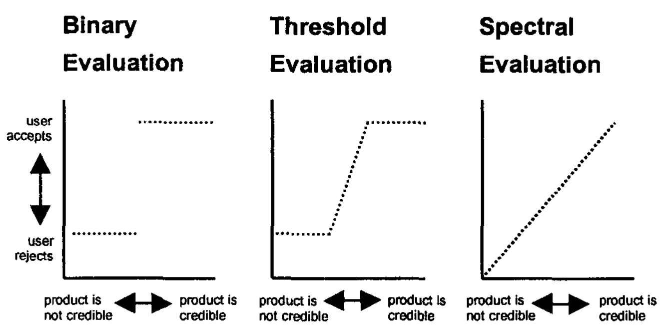

Figure A: These three models represent different approaches to evaluating credibility.

Binary Evaluation of credibility

The simplest strategy for evaluating a computer product is what we call "Binary Evaluation"; users perceive the product as either credible or not credible—no middle ground. Users are more likely to adopt the Binary Evaluation strategy when users have—

- low interest in the issue
- low ability to process information, either due to cognitive abilities or situational factors
- little familiarity with the subject matter
- no reference points for comparison

Any one of the above elements can lead to Binary Evaluations. An example of someone likely to use this strategy would be an unmotivated student seeking information on the Web for a history paper due the next day.

Threshold Evaluation of credibility

The Threshold Evaluation strategy includes upper and lower thresholds for credibility assessments. If a computer product exceeds the upper threshold, users deem it credible; if it falls below the lower threshold, it is deemed not credible. If the product falls between the two thresholds, then the perceiver may describe the product as "somewhat credible" or "fairly credible." We propose that people use a threshold strategy in evaluating computer credibility when they have—

- moderate interest in the issue
- moderate ability to process information, either due to cognitive abilities or situational factors
- partial familiarity with the subject matter
- moderate ability to compare various sources

An example of someone likely to use a Threshold Evaluation strategy would be a tourist using an information kiosk in order to find a suitable restaurant for dinner.

Spectral Evaluation of credibility

The most sophisticated—and most difficult—evaluation strategy is what we call Spectral Evaluation. This model offers no black or white categories; each evaluation is a shade of gray. We propose that people use a spectral strategy for evaluating computer credibility when users have—

- high interest in the issue
- high ability to process the information, including favorable cognitive and situational factors
- high familiarity with the subject matter
- considerable opportunity to compare various sources

All the above elements must be present to facilitate Spectral Evaluation. One example of a person adopting this strategy would be an individual who is searching for a solution to his or her own terminal illness.

ELM and designing for credibility

Most people use all three credibility evaluation models in different situations, with the threshold model being the most flexible and the most common. But what determines which model people follow? The bullet-point guidelines we offer above are adaptations of the Elaboration Likelihood Model (ELM) [32, 33]. According to the ELM, people can process information through two routes: central and peripheral. People opt for the peripheral processing route when they have little personal involvement with the issue or when they lack ability or motivation to process the information. In contrast, people process centrally when they have high personal involvement in the issue and are able to devote adequate cognitive resources.

The models of credibility evaluation and the ELM have design implications for computer products. For example, if the computer product is intended for users with low involvement or limited cognitive ability, then designers concerned about credibility need only focus on peripheral cues such as attractiveness of source, number of arguments, likability of source, and so on. If, on the other hand, the computer product is one that is highly involving and very important to the user, then users will tend toward spectral evaluations of credibility. In this case, users are likely to focus heavily on the content and less on peripheral cues when assessing trustworthiness or expertise.

TOWARD NEW RESEARCH IN COMPUTER CREDIBILITY

To this point, we have defined key terms, synthesized previous research, and proposed three new frameworks for computer credibility. We next aim to facilitate new research in this domain (1) by outlining two perspectives on what users evaluate when assessing computer credibility, and (2) by providing a set of key terms for researching and evaluating computer credibility.

What do users evaluate when assessing credibility?

Throughout this paper we have discussed users evaluating the credibility of "computer products," a general phrase we use to describe many types of computer devices, systems, and applications. So now we ask, "What precisely are users focusing on when they evaluate the credibility of a 'computer product'?" No existing research fully answers this question, so below we offer two perspectives: a systems perspective and a psychological perspective.

The systems perspective on credibility assessment

In assessing credibility, we hypothesize that people can evaluate four different aspects of a computer product: the device, the interface, the functionality, and the information.

Device credibility relates to the physical aspect of the computing product. For example, a pocket calculator can have a physical design, a density, and button detents that induce perceptions of credibility.

Interface credibility relates to the display of the computer product as well as to the interaction experience. For example, an interface is likely to be perceived as less credible when it contradicts user expectations or mental models.

Functional credibility relates to what a computer product does and how it is done. This includes performing calculations, services, or processes. Functional credibility is most closely related to a strict definition of *trust*, as discussed earlier.

Information credibility relates to how believable the information is from the computing product. For example, information that contradicts what a user views as "correct" (even typographical errors) will reduce credibility.

By pairing these four aspects of a computer product with the two dimensions of credibility, one can isolate specific issues for research, evaluation, and design (see Table 3).

Device Credibility	Interface Credibility	Functional Credibility	Information Credibility
Trustworthiness Issues	Trustworthiness Issues	Trustworthiness Issues	Trustworthiness Issues
Expertise Issues	Expertise Issues	Expertise Issues	Expertise Issues

Table 3: Aspects of computer credibility from a systems perspective

People who research, evaluate, or design computer products with credibility in mind can benefit from differentiating aspects of a computing system, as shown in Table 3. For example, hardware designers may accept the challenge of making the device seem trustworthy, one cell in the matrix. Web site evaluators would likely target other issues, such as the six cells that relate to the interface, the function, and the information. HCI researchers may focus on just a single cell of Table 3 (for example, Kim and Moon [15] focus exclusively on trustworthiness perceptions of interfaces).

Although HCI professionals can—and should—parse out different aspects of a computer product's credibility, people who use computers are unlikely to make these distinctions easily. Research suggests that people may not naturally separate the credibility of one aspect of a computer product from another [27]. Subsequently, the credibility perceptions about one part of the computer—good or bad—will likely affect credibility perceptions of the entire product. For a common and anecdotal example, consider perceptions of the early Macintosh computer. The industrial design was perceived as "cute." Because cuteness does not likely correlate with credibility, many people dismissed the entire Macintosh computing system.

The psychological perspective on credibility assessment

In addition to the systems perspective, we also propose that computer users adopt a psychological perspective in evaluating credibility. For example, if a computer product provides information, who or what is the perceived source of the information? Below we propose four "psychological targets" for credibility assessments, listed from the most psychologically immediate to the least:

On-screen characters - If on-screen characters are part of a computing product, they are likely the most immediate psychological target for credibility evaluation [20, 35].

Computer *qua* computer - The next most immediate target of credibility evaluation is the computer itself. Research shows that people make credibility assessments about computers [34, 35] and that evaluations of the computer are more natural for users than evaluations of the person who created the computer product [35].

Brand - The brand of the computer product may be the next psychological target for evaluation. This includes the company or institution that promotes the computer product.

Expert creator - The expert who created the computer product is perhaps the most rational target for credibility evaluation, but we propose that for most computer users the expert creator may be the least immediate psychological target of the four.

By pairing these four psychological targets of credibility evaluations with the two dimensions of credibility, one can isolate specific issues for research, evaluation, and design (see Table 4).

Credibility of on-screen character	Credibility of computer *qua* computer	Credibility of brand	Credibility of expert creator
Trustworthiness Issues	Trustworthiness Issues	Trustworthiness Issues	Trustworthiness Issues
Expertise Issues	Expertise Issues	Expertise Issues	Expertise Issues

Table 4: Psychological targets for credibility evaluations.

As Table 4 shows, people can target different psychological sources in making credibility assessments about a computer product. One resulting design strategy would be to emphasize the psychological target that has the greatest perceived trustworthiness and expertise. This may mean highlighting the product brand, if the brand has a high reputation for credibility, or it may mean highlighting the experts who created the product. How to enhance the credibility perception for each cell in Table 4 is an important area for additional research and design.

Key terminology for investigating credibility

We hope this paper has suggested profitable areas for discovery about computers and credibility—and we hope to inspire others to join us in these endeavors. To this end we now suggest terminology that can serve in evaluating and researching credibility. Table 5 offers specific terms for assessing credibility of computer products, as well as assessing the two dimensions of credibility: trustworthiness and expertise.

Terms for assessing credibility	Terms for assessing trustworthiness	Terms for assessing expertise
credible	trustworthy	knowledgeable
believable	good	competent
reputable	truthful	intelligent
"trust the information"	well-intentioned	capable
"accept the advice"	unbiased	experienced
"believe the output"	honest	powerful

Table 5: Basic terms for assessing the credibility of computer products

In using the above terminology, investigations into computer credibility can either examine the credibility of the computer product as a whole, or they can probe the credibility of a specific aspect (e.g., device, interface, functionality, information). In doing so, investigators can use the terminology in Table 5 in a variety of ways—as Likert-type scales (with the responses of *strongly agree, agree, neutral, disagree, strongly disagree*) or as semantic differentials (e.g., with "capable" and "not capable" on two ends of a scale). Although the items in Table 5 do not comprise a standard scale, most of the terms in the table have proven successful in HCI research [7, 30]. As an HCI community, we do not yet have a standard credibility scale for our work in evaluation, design, and research; therefore, we suggest using the items in Table 5 as a step toward creating a valid and reliable "Computer Credibility Scale."

LOOKING FORWARD

Our intent in this paper has been to raise awareness in the HCI community about the elements of computer credibility in order to encourage additional work in this area. To the best of our knowledge, this paper makes a unique contribution to the field of human-computer interaction because it is the first document to synthesize the previous research in computer credibility, to suggest new frameworks for understanding this domain, and to propose various issues for continued research, evaluation, and design of credible computing products.

The scope of this paper has been as broad as possible in order to capture credibility issues common to most computer products. We hope that this paper can help lay a foundation for future work that focuses on increasingly specific issues, expanding and revising topics we have addressed here. In this way, our HCI community can not only increase our understanding about the elements of computer credibility, but we can also use this understanding to enhance our research, evaluation, and design efforts.

REFERENCES

1. Andrews, L.W. & Gutkin, T.B. (1991). The Effects of Human Versus Computer Authorship on Consumers' Perceptions of Psychological Reports. *Computers in Human Behavior*, 7, 311-317.
2. Bauhs, J.A. & Cooke, N.J. (1994). Is Knowing More Really Better? Effects of System Development Information in Human-Expert System Interactions. *CHI 94 Companion*, p. 99-100. New York: ACM.
3. Buller, D.B. & Burgoon, J.K. (1996). Interpersonal Deception Theory. *Communication Theory*, 6(3) 203-242.
4. Byrne, D. (1971). *The Attraction Paradigm*. New York: Academic.
5. Chaiken, S. (1979). Communicator Physical Attractiveness and Persuasion. *Journal of Personality and Social Psychology*, 37, 1387-1397.
6. Cialdini, R.B. (1993). *Influence: Science and Practice*. (3rd ed.). New York: HarperCollins.
7. Fogg, B.J. (1997). *Charismatic Computers: Creating more likable and persuasive interactive technologies by leveraging principles from social psychology*. Doctoral thesis. Stanford University.
8. Fogg, B.J. (1998). Persuasive Computers: Perspectives and research directions. *Proceedings of the CHI98 Conference of the ACM/SIGCHI*, 225-232. New York: ACM Press.
9. Gatignon, H., & Robertson, T.S. (1991). Innovative Decision Processes. T.S. Robertson & H.H. Kassarjian (Eds.), *Handbook of Consumer Behavior*. Englewood Cliffs, NJ: Prentice-Hall.
10. Hanowski, R.J., Kantowitz, S.C., & Kantowitz, B.H. (1994). Driver Acceptance of Unreliable Route Guidance Information. *Proceedings of the Human Factors Society 38th Annual Meeting*, p. 1062-1066.
11. Harkins, S.G., & Petty, R.E. (1981). Effects of Source Magnification of Cognitive Effort on Attitudes: An information processing view. *Journal of Personality and Social Psychology*, 40, 401-413.
12. Honaker, L.M., Hector, V.S., & Harrell, T.H. (1986). Perceived Validity of Computer Versus Clinician-Generated MMPI Reports. *Computers in Human Behavior*, 2, 77-83.
13. Kantowitz, B.H., Hanowski, R.J., & Kantowitz, S.C. (1997). Driver Acceptance of Unreliable Traffic Information in Familiar and Unfamiliar Settings. *Human Factors*, 39(2) 164-176.

14. Kerber, K.W. (1983). Attitudes Towards Specific Uses of the Computer: Quantitative, decision-making and record-keeping applications. *Behavior and Information Technology*, 2, 197-209.

15. Kim, J. & Moon, J.Y. (1997). Designing Towards Emotional Usability in Customer Interfaces: Trustworthiness of cyber-banking system interfaces. *Interacting with Computers*, 10, 1-29.

16. Larson, C. (1995). *Persuasion: Reception and responsibility*. (7th ed.). Belmont, CA: Wadsworth.

17. Lee, J. (1991). The Dynamics of Trust in a Supervisory Control Simulation. *Proceedings of the Human Factors Society 35th Annual Meeting*, p. 1228-1232.

18. Lee, J. & Moray, N. (1992). Trust, Control Strategies and Allocation of Function in Human-Machine Systems. *Ergonomics*, 35(10), 1243-1270.

19. Lerch, F.J. & Prietula, M.J. (1989). How Do We Trust Machine Advice? Designing and using human-computer interfaces and knowledge based systems. *Proceedings of the Third Annual Conference on Human Computer Interaction*. p. 411-419. Amsterdam: Elsevier.

20. Lester, J.C., Converse, S.A., Kahler, S.E., Barlow, S.T., Stone, B.A., & Bhogal, R.S. (1997). The Persona Effect: Affective impact of animated pedagogical agents. *Proceedings of CHI 97*. p. 359-366. New York: ACM.

21. Mackie, D.M., Worth, L.T., & Asuncion, A.G. (1990). Processing of Persuasive In-group Messages. *Journal of Personality and Social Psychology*, 58, 812-822.

22. Matarazzo, J.D. (1986). Response to Fowler and Butcher on Matarazzo. *American Psychologist*, 41, 96.

23. Miller, C.A. & Larson, R. (1992). An Explanatory and "Argumentative" Interface for a Model-Based Diagnostic System. *Proceedings of the ACM Symposium on User Interface Software and Technology, 1992*, 43-52.

24. Moon, Y. (1998). The Effects of Distance in Local Versus Remote Human-Computer Interaction. *In Proceedings of CHI 98*, p. 103-108. New York: ACM.

25. Muir, B.M. (1988). Trust Between Humans and Machines, and the Design of Decision Aids. *Cognitive Engineering in Complex Dynamic Worlds*. p. 71-83.

26. Muir, B.M. (1994). Trust in Automation: Part I. Theoretical issues in the study of trust and human intervention in automated systems. *Ergonomics*, 37(11) 1905-1922.

27. Muir, B.M. & Moray, N. (1996). Trust in Automation: Part II. Experimental studies of trust and human intervention in a process control simulation. *Ergonomics*, 39(3) 429-460.

28. Nass, C., Fogg, B.J., & Moon, Y. (1996). Can Computers Be Teammates? *International Journal of Human-Computer Studies, 45*, 669-678.

29. Nass, C., Reeves, B., & Leshner, G. (1996). Technology and Roles: A tale of two TVs. *Journal of Communication*, 46(2).

30. Nass, C., Moon, Y., Fogg, B.J., Reeves, B. & Dryer, D.C. (1995). Can Computer Personalities Be Human Personalities? *International Journal of Human-Computer Studies*, *43*, 223-239.

31. Pancer, S.M., George, M., & Gebotys, R.J. (1992). Understanding and Predicting Attitudes Toward Computers. *Computers in Human Behavior*, 8, 211-222.

32. Petty, R. and Cacioppo, J. (1981). *Attitudes and Persuasion: Classic and contemporary approaches*. Dubuque, IA: Brown.

33. Petty, R., Cacioppo, J., Goldman, R. (1981). Personal Involvement as a Determinant of Argument-Based Persuasion. *Journal of Personality and Social Psychology*, 41(5) 847-855.

34. Quintanar, L., Crowell, C., Pryor, J. (1982). Human-Computer Interaction: A preliminary social psychological analysis. *Behavior Research Methods and Instrumentation*, 14(2) 210-220.

35. Reeves, B. & Nass, C. (1996). *The Media Equation: How people treat computers, television, and new media like real people and places*. New York: Cambridge University.

36. Rempel, J.K., Holmes, J.G, & Zanna, M.P. (1985). Trust in Close Relationships. *Journal of Personality and Social Psychology*, 49 (1) 95-112.

37. Rotter, J.B. (1980). Interpersonal Trust, Trustworthiness, and Gullibility. *American Psychologist*, 35 (1) 1-7.

38. Self, C.S. (1996). Credibility. In M. Salwen & D. Stacks (Eds.), *An Integrated Approach to Communication Theory and Research*. Mahway, NJ: Erlbaum.

39. Sheridan, T.B., Vamos, T., and Aida S. (1983). Adapting Automation to Man, Culture and Society. *Automatica*, 19(6) 605-612.

40. Stiff, J. (1994). *Persuasive Communication*. New York: Guilford.

41. Waern, Y. & Ramberg, R. (1996). People's Perception of Human and Computer Advice. *Computers in Human Behavior*, 12(1) 17-27.

42. Waern, Y., Hagglund, S. et al. (1992). Communication Knowledge for Knowledge Communication. *International Journal of Man-Machine Studies*, 37, 215-239.

43. Zajonc, R.B. (1980). Feeling and Thinking: Preferences need no inferences. *American Psychologist*, 35, 151-175.

44. Zimbardo, P. & Leippe, M. (1991). *The Psychology of Attitude Change and Social Influence*. New York: McGraw-Hill.