

THE RELATIONSHIP BETWEEN VISUAL ABSTRACTION AND THE EFFECTIVENESS OF A PEDAGOGICAL CHARACTER-AGENT

Hanadi Haddad and Jane Klobas*

Curtin University of Technology, Perth, Western Australia

*also at Bocconi University, Milan, Italy

Growth in Internet use and the market for online education¹ have created a demand for computer-based delivery of educational content. Associated with this demand has been experimentation in development of character-agents with the potential to deliver educational content (e.g., Marriott et al. 2001; *INTERFACE: Multimodal Analysis/Synthesis System for Human Interaction to Virtual and Augmented Environments* 2000; Information Societies Technology, IST, Programme 1999). Much of this development has concentrated on achieving realistic or lifelike agents, yet there is little research on the relationship between the way in which a character-agent is represented and its effectiveness as a communicator. This paper describes research designed to investigate the influence of one aspect of character-agent representation, the degree of visual abstraction, on the effectiveness of information transfer to a user.

Representation of character-agents

A character-agent can be defined as a computer-based program that performs a particular function and is embodied or manifest audiovisually via a screen-based synthetically or artificially constructed character. The two elements of a character-agent (*agent* and *character*) reflect assumptions about the characteristics of a 'good' synthetic agent. A software *agent* includes the properties of being reactive, autonomous, goal-oriented, and temporally continuous (Franklin & Graesser 1996). A *character* has characteristics which include '... believable "personality" and emotional state' (p. 4). Research on the representation of character-agents emphasises users' personal response to these characteristics. It focuses on users' perceptions of the extent to which an agent has met the goals of believability and emotional range (Lester et al. 1997; Beard et al. 1999) rather than outcomes of use, such as the ability of the agent to deliver information effectively.

Experts in human-computer interaction assume that the closer communication with a character-agent matches communication among humans, the better that communication will be (Kurzweil, 1992). In the aspiration to create more natural communication processes, the creation of anthropomorphised synthetic entities has been thought of as an obvious and natural solution (Shaw et al. 1999). Studies conducted by Stanford University researchers have investigated the theory that the computer – and even more so its anthropomorphic projections such as character-agents – is treated as a social actor by human users (Nass et al. 1994; Nass & Moon 2000). Human users were seen to apply rules and behaviors of social interaction and conventions towards computers exhibiting often quite minimal characteristically human cues such as voice and on screen facial representation (Nass et al. 1994).

Research on users' emotional or affective response to character-agents has identified many factors to consider in the design of their audiovisual representation. These factors, when combined, form the embodiment of a character-agent. When investigating the effect of a specific factor or set of factors the other complementing factors should also be taken into account. Some examples of factors to consider when creating and evaluating an audiovisual representation are:

- *Believability*, a factor the Oz Project Group from Carnegie Mellon University describes as important for affective engagement 'As autonomous agents become richer, we believe it will become increasingly important for some of the agents to have believable and engaging personalities' (Loyall & Bates 1993).
- *Personality*, for example, as attributed to the mega-computer HAL in the movie *Space Odyssey 2001* (2001: *A Space Odyssey* 1968, [video recording]) and as described by Nass et al. (1995) as an important factor for believable agents.
- *Appropriateness* to context, such as the tone of voice of cyberassistant character Mya, Motorola's voice-activated web browser, a 24 hour talking Internet service (Larsen 2000). Writer and associate creative director Pete Jones of the advertising firm McCann-Erickson said, "We wanted a voice that exuded some confidence and accountability, because Mya is someone who's going to deliver all this information," (Larsen 2000, p. 90).

While some designers and researchers have explicitly considered the particular audiovisual representation of a character and its effect along several dimensions, there have been no empirical tests of the

¹ The market for eLearning in higher education has been estimated to be worth almost USD750 million by 2004 (*NUA Internet Surveys* 2000).

communicative effectiveness of different representations. However, how or why a particular representation may or may not be more effective than another in terms of information delivery is worthy of investigation. It is the contention of this research that character-agent visual representation influences the effectiveness of information delivery.

Wilson (1997) discusses the difficulties in designing representations of character-agents: 'What would make a good character, and representation?' (p. 6). He outlines a selection of film animation principles such as appeal, staging, timing and realism and their potential application in the context of character-agent design. He also outlines a selection of non-propositional cues in human expression such as physical appearance, body movement and posture, facial expression, eye contact, intonation, word choice and grammar and proposition content of speech and considers whether this approach towards realism may create too high an expectation of a character-agent's abilities. Indeed, Wilson suggests that more realistic character-agents may introduce distraction associated with the user's curiosity about the personality of the character and over-reading of unintended messages because of presentation complexity.

The view that detail is associated with distraction is consistent with the theory and practice of information designers who work outside the character-agent field. In general, abstract representations are believed by these graphic designers to be more effective in conveying information because their lack of detail allows people to focus more on the information content:

Unlike detailed realistic drawings, sketches help focus the mind on what is important, leaving out or vaguely hinting at other aspects. Sketches promote the participation of the viewer. People give more, and more relevant, comments when they are presented a sketch than when they are given a detailed drawing. A realistic drawing or rendering looks too finished and draws attention to details rather than the conceptual whole (Stappers et al, 2000).

This point of view seems inconsistent with attempts to make character-agents for information transfer more life-like.

On the other hand, research by psychologists suggests that people may put considerable cognitive effort into processing abstract representations of faces (Bruce et al. 1992; Hay & Young 1982). It is possible, therefore, that response to anthropomorphised character-agents, and especially their faces, may differ from responses to sketches. Gregory and his colleagues (1995) conducted studies on human response to faces at the physiological level. They demonstrated that humans are particularly receptive to faces. In terms of recognition, participants in their studies were more responsive to real faces than to abstracted line faces. They speculated, however, that people spend longer studying abstracted line faces and may find them more interesting (Gregory et al. 1995). If this is so, then contrary to theories of information design, an abstract face may introduce more distraction into the communication than a realistic face.

Classical communication theory provides one framework within which to analyse and test these apparently contradictory predictions. Berlo (1960), drawing on the Shannon and Weaver (1948) communication model, represented the components of communication as source, message, channel and receiver (SMCR). Where source, message and receiver are constant, a channel with noise is less effective than one without noise (Bello 1953). Within this model, a character-agent may be considered a channel through which a message may be communicated, and we might hypothesise that the less cognitive distraction associated with the representation of a character-agent, the less noise, and therefore the more effective the agent as a communicator.

Hermeneutic and postmodern theories of computer-mediated communication recognize that information transfer involving humans is more complex than the Berlo representation (Hlynka, 1996). These theories focus on the interpretation and meaning a user places on information (such as a lecture delivered by a character-agent), the importance of the context in which the communication takes place, and the role of the mediating technology as a non-neutral 'actor' in the communication process. This research is concerned with contexts such as education where the communication of interest consists of data or 'facts' – such as dates, times, and rule-based knowledge and procedures such as HTML tags – which external standards require users to 'know' if they are to share the existing socially constructed meaning of these data. In these cases, the effectiveness of communication of the specific messages of interest is measured by the extent to which the user learns new 'facts' through the communication, regardless of the additional meaning conveyed. Nonetheless, additional meanings may distract from, or contribute positively to, the communication. In these, as in other contexts, character-agent technology is decidedly non-neutral, contributing to meaning as well as to the effectiveness of communication. Recognition that representation of the synthetic character-agent is non-neutral specifically drives this research.

Thus, this research focuses on users' responses to different representations of character-agents for

information transfer, and considers contextual and user response characteristics as well as the role of visual abstraction in the effectiveness of the communication process. The research specifically considers how the visual representation of a character-agent for information delivery is associated with the effectiveness of learning. The phased research successively considers, and then compares, researcher, practitioner and user views of character-agents. It culminates in an empirical test of the relationship between one aspect of their representation, visual abstraction, and the effectiveness of information transfer. The remainder of this paper describes the research and results-to-date by the three principal phases.

Phase I, Theories of the ‘good’ character-agent: A model from the literature

In the first phase of this research, a literature review was conducted to identify what are considered to be the qualities of a ‘good’ character-agent. Two sets of literature were examined: the academic literature, as a source of theory and empirically tested criteria; and the practitioner literature, to identify theories-in-action. The characteristics studied or described in this literature have been grouped into categories representing similar characteristics. The primary classifications and examples of characteristics included within them are presented in Table 1, which appears at the end of this paper.

User response to character-agents, as described in the literature, has been classified as either affect (personal or emotional response, or how the user feels about the agent and its use) or effect (the effectiveness of the agent in achieving its aims to either inform or entertain). Although the effectiveness of pedagogical agents has been studied and compared with that of learning from text (Moreno et al., 2000), there has been no research on the relationship between agent characterisation and the effectiveness of the agent for information delivery. Most of the literature which refers to effectiveness assumes that effectiveness is an outcome of positive affective response (i.e., that the agent is likeable, realistic and engaging). Although there are few tests of this relationship, there may well be a link between affect and effect, at least in the field of education. Educators work to develop a learning environment which engages learners affectively in the belief that such an environment stimulates deeper learning and motivation to continue to learn (Woolfolk, 2002). The key elements of the theories-in-use and the proposed relationships have been mapped in a model which appears in Figure 1.

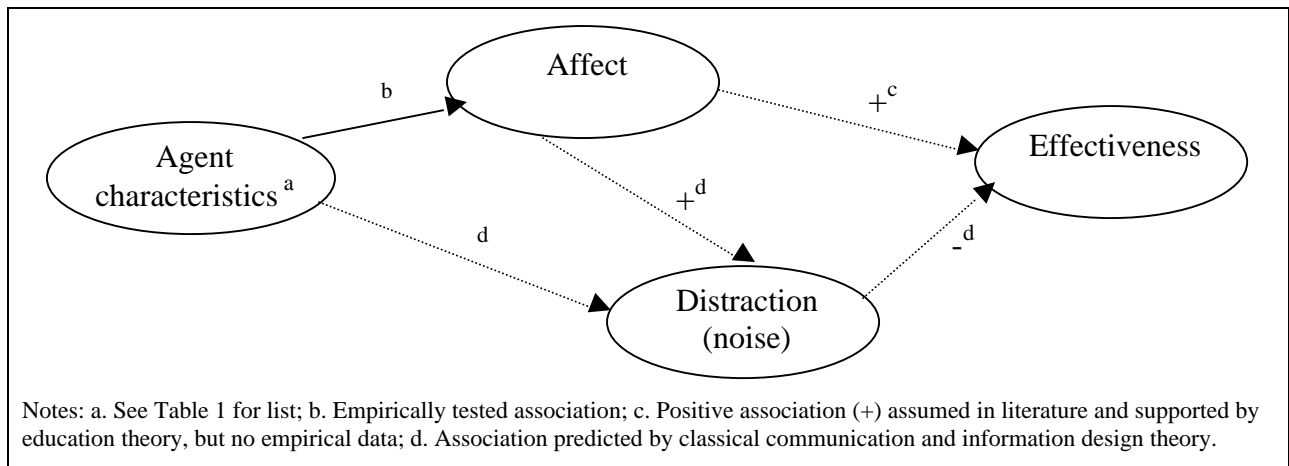


Figure 1. A model of the relationship between character-agent design elements and effectiveness in information delivery.

Phase II, The ‘good’ character-agent in practice: Practitioner interviews

The second phase of the research was designed to identify practitioner criteria for character-agent quality, and to enable comparison between practitioner theories-in-action and the theories and heuristics presented in the literature. Designers and developers who are acknowledged by their peers as leaders in character-agent design and development are being interviewed in this phase. Structured interviews with open-ended questions are being conducted, either face-to-face or by e-mail where the interviewees are distant from members of the research team. Follow-up email is sent where clarification is required.

To date, eight interviews (around 45 minutes face-to-face) have been conducted, four with computer scientists developing a talking head for information delivery and four with practising multimedia designers and animators. These groups were selected in order to identify the views of the range of professionals currently working in the field. While the first group is specifically developing informational agents, they have had little commercial experience. The second group has commercial experience in development of

characters or agents, but less specific experience in development of informational character-agents. The aim is to conduct sufficient interviews to identify similarities and differences between the practising designers theories-in-action and those expressed in the literature. Based on the patterns which have emerged from the interviews analysed to date, we expect 8-10 interviews with this set of developers will be sufficient. As the field develops, commercial designers of character-agents for information delivery are emerging, and additional interviews will be held with a sample of such designers later in the year.

Statements made in the interviews are being classified using the scheme which emerged from the literature review. Additional characteristics or relationships have been recorded in an extended table of theories-in-action. Table 1 includes a summary of the concerns of six of the interviewees. In addition to the characteristics and relationships mentioned in the interviews, the tone and emphasis of the interviewees has been used to identify potential differences in the concerns of the practitioners and writers in the field.

The interviews analysed to date suggest that practitioners (agent developers) focus on a limited sub-set of the characteristics described in the literature. These practitioners are concerned with producing agents that meet their expectations (or their peers' expectations) of 'good' agents along those criteria, but make few explicit links between the qualities they seek to attain and the outcomes important to educators and other information providers.

Preliminary comparison of the emphasis of practitioners' remarks in interviews and the published literature suggest some differences between published theories and heuristics and practitioners' theories-in-action. These include the pressure to satisfy the client; we have provisionally classified this an extension of the notion of appropriateness, from appropriate to the role of the agent (such as teaching) to appropriate to the client's purpose such as presenting the training firm in a good light. The practitioners' remarks are more subjective with a stronger focus on their own emotional response and those of their peers than the literature, which is more clinical in its representative of the criteria for recognition of a good agent. One interviewees' remarks illustrate the relationship between these characteristics:

Character is successful if sales and reviews are good (ultimately), as well as fellow designers like it, client likes it. (Designer/character animator)

For some practitioners, personal preference may take precedence over the characteristics the literature assumes are associated with a good agent:

Real is good to show your skills off, but it isn't that interesting to look at. (Multimedia designer/character animator)

While the research literature tends to consider or analyse the effect of characteristics one by one, leaving implicit the relationship between the characteristics, the practitioners – like the designer-based practitioner literature (e.g. Wilson, 1997) – place a higher emphasis on the integrity of the technical elements of the agent, and of the relationship between the technical elements and the agent's purpose. The practitioners criticised the notion of stereotype but introduced the notion of story as a way to capture this type of integrity. Their comments include:

Less computery, more emotion, more human – we identify. Proper voice helps you understand – multiple communication channels. (Computer Science/Talking Head developer)

The story for this character is that he was a human but his DNA has been spliced with some insect DNA ... (Multimedia designer/character animator)

Phase III, Visual abstraction and effectiveness: Experimental studies of user response

The first two phases of the research suggest that, while the character-agent literature is primarily concerned with creating realistic, anthropomorphic, believable and engaging characters, practitioners are more concerned with engagement, story and integrity, and strongly influenced by the expectations of the practitioners' sponsors and their peers. While the literature notes that good character-agents are believed to be associated with effective information transfer, practitioners seem less concerned about this relationship. In both cases, greater emphasis is placed on affective user response rather than effective information transfer. In the third phase of the research, our attention therefore turns to the users themselves, and to the relationship between character-agent representation and effectiveness of information transfer. User perceptions of character-agents and the relationship between representation and effectiveness will be tested in a series of empirical user studies.

The first study in this series is developing and psychometrically testing an instrument to measure user response to character-agents. Each of the heuristics identified from the literature and practitioner interviews

has been converted into a semantic differential (e.g., *I found the agent to be: believable ... not credible; interesting ... boring*). A total of 51 pairs has been developed to represent the heuristics. Study participants will view a short lecture segment presented by a character-agent. (Prototypes of the character-agents used in this study are illustrated in Figure 2. The working prototypes can be found at <http://www.famous3d.com/temp/curtin/>. The lecture segments have been developed and tested for validity and reliability and for suitability across cultural and language groups by external educational testing services.) After viewing the lecture segment, participants will rate the agent's characteristics by marking a point between the two anchors of the semantic differential. Item response analysis will be used to identify items which represent true pairs, and factor analysis will be used to classify the heuristics into categories of agent characteristics. This step is necessary to develop valid and reliable measurement instruments for later experimental studies. It will, however, also enable us to make a significant advance in understanding of user response to character-agents. This study will identify the dimensions along which users respond to character-agents for information delivery. By enabling us to confirm or revise the character-agent design heuristic classification scheme presented in Table 1, it will also provide a reliable basis for 3-way comparison between the concerns of researchers, practitioners and users.



Figure 2. Prototypes of agents used in identifying dimensions of user-response: a. Realistic 'girl'; b. Schematic 'smiley'.

Subsequent laboratory studies will use the model illustrated in Figure 1 to test the relationship between character-agent representation and effective information delivery. They will test if agents which meet criteria for good design introduce distraction or noise into the communication process, and if such distraction detracts from communication effectiveness as suggested by classical theories of information design and communication. They will also allow for the potential positive influence of affective response on effective information transfer, implied by the literature and practitioners theories-in-action and potentially consistent with modern theories of communication which acknowledge the complexity of communication environments. These studies will test the hypothesis:

Abstract visual representations for character-agents are more effective for information delivery than realistic visual representations for character-agents.

For these studies, a selection of three visual treatments of a character-agent will be chosen from the spectrum of iconic photorealistic (*realistic*) to abstracted schematic (*abstract*) representation (McCloud 1993). The character-agents will be in the form of three Talking Heads developed from those illustrated in Figure 3: one detailed and realistic treatment (extreme left), one lesser detailed treatment, and one least detailed treatment (extreme right). The figure shows how head size, facial shape and location of features will remain constant to control for differences in response to these characteristics.

Each participant in these studies will be randomly assigned to a visual treatment condition. There will be 30 participants in each condition. Random assignment should ensure that no systematic differences in user ability, preference, or other characteristics influence the results. Drawing on Berlo's (1960) SMCR model, the first experiment will hold the components of source and message (a lecture) and receiver (a university student) constant. Only the channel, consisting of the three different visual representations of the Talking Head, will be varied. Subsequent experiments will vary receiver characteristics such as familiarity with the Talking Head and gender, depending on the results of the first experiment.

The experiments will test effectiveness along three dimensions associated with learning: recall (or retention) of the information (the 'facts') delivered through the facilitation of the Talking Head, comparison of pieces of information, and application of learning (learning transfer) through judgement and problem solving in which the information is applied in a new domain (Moreno et al. 2000; Spool et al. 1997). For this last outcome, we are not seeking a single correct answer; we are concerned only that users can make such

Iconic Photorealistic-----|**Iconic Schematic**-----|**Abstracted Schematic**



Figure 3. Illustration of the representations to be compared.

judgements based on the information presented. After the lecture segment has been viewed and the test questions answered, user perception of agent characteristics, affect and distraction will be measured using the questionnaire developed in the first user study. Analysis of variance will be used to test for differences in the effectiveness of each form of visual abstraction. Multiple regression will be used to compare the relative influence of affect and distraction on effectiveness.

In the final user studies in this research, verbal protocol analysis (Ericsson & Simon 1993) will be used to enrich understanding of affective response and user cognition (including, but not limited to, distraction) during use.

--	--	--	--

Conclusions

To date there has been little research on how the representation of a pedagogical agent is related to its effectiveness. Indeed, there is little concern among practitioners in particular, for the informational outcomes character-agent use. Instead, practitioners continue to focus on designing or developing ‘good’ agents as measured by the criteria internally generated by fellow designers and developers and the requirements of clients who commission agents. Researchers in the field have been more concerned with the outcomes of character-agent use, but their concerns focus more on responses associated with affect than with effect. The research described in this paper tests the fields’ criteria for good character-agent design, and the underlying assumption that realistic and engaging agent-characters are likely to be effective communicators of information. Such research is timely given the growth in demand for and interest in computer-supported learning.

Acknowledgements

We are grateful to Andrew Marriott and the Curtin University of Technology Talking Head team and to the team at Famous3D for providing the talking heads and images on which this research is based, and to Curtin University’s SOLIE and Cambridge University Testing Services for permission to use educational test material which they have developed. Thanks!

References

André, E., Rist, T. & Müller, J. 1997, ‘WebPersona: A Life-Like Presentation Agent for the World-Wide Web’, Presented at *Animated Interface Agents: Making them Intelligent (in conjunction with IJCAI-97)*, Nagoya, Japan.

Ball, G., Ling, D., Kurlander, D., Miller, J., Pugh, D., Skelly, T., Stankosky, A., Thiel, D., Van Dantzich, M. & Wax, T., 1997, ‘Lifelike Computer Characters: the Persona project at Microsoft Research’, *Persona @ Microsoft Research*, [Online], Available: <http://www.research.microsoft.com/research/ui/persona/chapter/persona.htm> [2001, February 13].

Beard, S., Crossman, B., Cechner, P. & Marriott, A. 1999, ‘FAQBot’, in *Proceedings of Pan Sydney Area Workshop on Visual Information Processing November 10 1999*, University of Sydney, Australia.

- Bello, F. 1953, *The Information Theory*, in *Readings in Management Information Systems*, eds G. B. Davis & G. C. Everest, McGraw-Hill Book Company, New York, pp. 23-32.
- Berlo, D. K. 1960, *The Process of Communication*, Holt, Rinehart and Winston, Inc, New York.
- Bruce, V., Cowey, A., Ellis, A. W. & Perrett, D. L. 1992, *Processing the Facial Image*. Oxford, UK, Clarendon Press.
- Ericsson, K. A. & Simon, H. A. 1993, *Protocol Analysis: Verbal Reports as Data Revised Edition*, The MIT Press, Cambridge Massachusetts.
- Franklin, S. & Graesser, A. 1996, 'Is it an Agent, or just a Program?: A Taxonomy for Autonomous Agents', in *Proceedings of the Third International Workshop on Agent Theories, Architectures, and Languages*, Springer-Verlag, [Online], Available: <http://www.mscl.memphis.edu/~franklin/AgentProg.html> [2001, February 13].
- Gregory, R., Harris, J., Heard, P. & Rose, D. (eds) 1995, *The Artful Eye*, Oxford University Press, Oxford.
- Hay, D.C., Young, A.W. 1982, 'The human face', in *Normality and Pathology in Cognitive Function*, Ellis, A.W. ed., London, Academic Press, pp. 173-202.
- Hlynka, D. (1996). Postmodernism. In D. H. Jonassen (Ed.), *Handbook of Research for Educational Communications and Technology* (www.aect.org/Intranet/Publications/edtech/index.html), 10. Postmodern and Poststructural Theory, pp. 11-14). New York: Simon & Schuster Macmillan. [2001, June 7]
- Information Societies Technology (IST) Programme 1999, *Annex 1 – "Description of Work"*, INTERFACE: Multimodal Analysis/Synthesis System for Human Interaction to Virtual and Augmented Environments, Project Number IST-1999-No. 10036.
- INTERFACE: Multimodal Analysis/Synthesis System for Human Interaction to Virtual and Augmented Environments 2000, [Online], Available: <http://www.ist-interface.org> [2001, June 11].
- Kurzweil, R. 1992, *The Age of Intelligent Machines*, MIT Press, Massachusetts.
- Larsen, E. 2000, 'Mya Way', *I.D. Magazine*, Special Robots Issue, October, pp. 88-91.
- 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', in *Conference Proceedings on Human Factors in Computing Systems*, pp. 359 – 366.
- Loyall, A.B. & Bates, J 1993, 'Real-time Control of Animated Broad Agents', in *Proceedings of Fifteenth Annual Conference of the Cognitive Science Society*, Boulder, CO., [Online], Available: <http://www.cs.cmu.edu/Groups/oz/papers.html> [1999, March 7].
- Marriott, A., Beard, S., Haddad, H., Pockaj, R., Stallo, J., Huynh, Q. & Tschirren, B. 2001, 'The Face of the Future', *Journal of Research and Practice in Information Technology*, vol. 32, no. 3/4, August/November, pp. 231-245.
- McCloud, S. 1993, *Understanding Comics: The Invisible Art*, Kitchen Sink Press Inc., Northampton, MA.
- Moreno, R., Mayer, R. E. & Lester, J. C. 2000, 'Life-Like Pedagogical Agents in Constructivist Multimedia Environments: Cognitive Consequences of their Interaction', in *Conference Proceedings of the World Conference on Educational Multimedia Hypermedia, and Telecommunications (ED-MEDIA)*, pp. 741-746, Montreal, Canada.
- Nass, C., Moon, Y., Fogg, B. J., Reeves, B. & Dryer, C 1995, 'Can Computer Personalities Be Human Personalities?', Short Paper in *Conference companion on Human factors in computing systems CHI '95*, p.228 – 229, Denver, Colorado, USA.
- Nass, C., Steuer, J., Tauber, E. & Reeder, H. 1993, 'Anthropomorphism, Agency, & Ethopoeia: Computers as Social Actors', *INTERACT '93 and CHI '93 conference companion on Human factors in computing systems*, pp. 111 – 112, Amsterdam, Netherlands.
- Nass, C., Steuer, J. and Tauber E. 1994, 'Computers are Social Actors' in *Conference proceedings on Human factors in computing systems: "celebrating interdependence" CHI '94*, pp. 72-78, Boston, Massachusetts, USA.
- Nass, C. & Moon, Y. 2000, 'Machines and Mindlessness: Social Responses to Computers', *Journal of Social Issues*, vol. 56, issue 1, p. 81-103.
- NUA Internet Surveys 2000, [Online], Available: <http://www.nua.com/surveys> [2001, May 18].
- Shannon, C. E. 1948, *A Mathematical Theory of Communication* (Based on original Bell System Technical Journal version), [Online], (1998, February 2 – last update) Available: <http://cm.bell-labs.com/cm/ms/what/shannonday/paper.html> [2001, May 11].
- Shaw, E., Johnson, W. L., Ganeshan, R. 1999, 'Pedagogical Agents on the Web' in *Proceedings of the third annual conference on Autonomous Agents99*, pp. 283 – 290, Seattle, WA, USA.

2001: *A Space Odyssey* [video recording] 1968, Metro Goldwyn Mayer Inc., Producer Stanley Kubrick.

Spool, J., Scanlon, T., Schroeder, W., Snyder, C., DeAngelo, T. 1998, *Website Usability: A Designer's Guide*, Morgan Kaufmann Publishers, San Francisco.

Stappers, P., Keller, I. & Hoeben, A. 2000, 'Aesthetics, interaction, and usability in 'sketchy' design tools', *Exchange Online Journal*, issue 1, December, [Online], Available: http://www.media.uwe.ac.uk/exchange_online/exch1_article4.php3 [2001, March 5].

Wilson, M. 1997, 'Metaphor to Personality: the role of animation in intelligent interface agents', Presented at *Animated Interface Agents: Making them Intelligent (in conjunction with IJCAI-97)*, Nagoya, Japan.

Woolfolk, A. 2002. *Educational Psychology*, 8th ed. Allyn and Bacon, Boston.

Table 1. Criteria for agent quality

Category	Criteria from literature include:	Criteria from developer interviews include:	^a No. and type of interviewees
<i>Personality</i>	Individual personality traits, solid personality, humor, quirks	Persona, character, appropriate attitude	5 (THI, ACE)
<i>Engagement</i>	Entertaining, engaging	Value of uniqueness, the 'wow' factor	5 (THI, ACE)
<i>Reliability</i>	Technical reliability	Meets technical requirements as a program or as defined by sponsor; fast and robust, does not break and therefore break the illusion	4 (THI, ACE)
<i>Realism</i>	Fine details, use of eyes,	Hair, face, anatomy, movement; resolution and detail such as texture, colour and graphic design; use of stereotypes	4 (THI, ACE)
<i>Appropriateness</i>	Flexibility to play different roles	Appropriate relationship between elements such as role, voice, hair, personality; trueness to stereotype; appropriate to client's purpose and audience	4 (THI, ACE)
<i>Believability</i>	Believable, reliable, credible	associated with realism	3 (THI)
<i>Voice</i>	Timing of pauses in speech, natural language capability, tone, pitch, personalized language style	Intonation & pitch, rate, range, expression of emotion, pronunciation, realism	3 (THI)
<i>Emotion</i>	Appropriate emotions, feelings		3 (THI)
<i>Body language, non-verbal communication.</i>	Awareness of body position, multiple channels for communication	Includes gesture and expressions	3 (THI, ACE)
<i>Cultural and social characteristics</i>	Social and language skills, gender and ethnicity, socially intelligent	A history and background, differences in perception associated with gender and ethnicity	3 (THI, ACE)
<i>Intelligence</i>	Intelligent inferences about the world around	Gives the impression that it's 'smart'	2 (THI)
<i>Anthropomorphism</i>	Lifelike, aware of environment and user, adaptive	Referred to as an entity and human or animal-like	2 (THI, ACE)
<i>Behaviour</i>	Goal-directed		2 (THI, ACE)
<i>Integrity</i>	Integrated, parallel behaviours	Synchronised speech, movement, voice	1 (THI)

a. THI = Talking Head for instruction, ACE = Character-agent, general and entertainment