Putting a Face on Embodied Interface Agents

John Zimmerman[1,2], Ellen Ayoob[1], Jodi Forlizzi[1,2], Mick McQuaid[3]

[1] Human-Computer Interaction Institute
[2] School of Design
Carnegie Mellon University
{johnz, ema, forlizzi}@cs.cmu.edu

[3] School of Information
University of Michigan
mcq@umich.edu

Abstract. Rapid increases in agent technology as well as the movement of computing into more and more social transactions has increased the need for embodied interface agents. However, interaction designers currently lack sufficient guidelines to confidently and successfully design the visual form of these agents. In this paper we offer a summary of research on the visual form of agents. In addition, we present our own study that explores the relationships between an agents visual form, the task it performs, and the demographics of users. As a result of the review and our own study, we frame the task of design of an agent's form as being similar to "casting". Finally, we offer some design guidelines to aid interaction designers in selecting human and non-human forms, in deciding how to address stereotypes, and in looking for opportunities to recast the agent's visual form.

1 Introduction

Embodied interface agents transform the experience of interacting with a computer, making it more social by explicitly referencing human-human interaction. When an agent's interaction design harmonizes with its tasks and the human's needs and expectations, wonderful things can happen. Apple's visionary *Knowledge Navigator* video with the embodied agent Phil, who assists a college professor in planning and managing the interaction between his work and family life through social dialog, provides a well-known projection of what embodied agents might do. However, Microsoft's much-maligned "Clippy"—an animated paperclip that often interrupts users when it recognizes an activity with an offer of "help", and who never remembers how users respond—provides a counterpoint, demonstrating how difficult it is to make embodied agents work in the real world.

Recent advances in technology and the invasion of computing into more and more social domains has created more opportunities for interfaces with embodied agents. From interfaces for controlling smart homes [2] to personal news-readers [1] to question answering systems [11]; interaction designers are being asked to create embodied agent interfaces, but they currently lack sufficient guidelines to make informed visual

and behavioral choices. While some behavioral research has explored how people react to embodied agents, this work has often produced contradictory results or has focused more on the issues of human behavior rather than producing visual design implications. Little to no work has been done to explore the visual design of embodied agents in real products.

In order to improve interaction designers' ability to produce more successful embodied agents in viable products, this paper presents (i) a review of research on the visual form of embodied agents, (ii) results of a new study looking at visual form as it relates to agent task, and (iii) a set of design implications to aid interaction designers in development of embodied agents. Our findings have convinced us to view the design of an embodied agent's visual form as a "casting" activity, where designers must select the best visual from based on the role the agent plays and the audience it is intended to perform for.

2 Background on Agents

The research community remains divided on many issues surrounding agents including a definition of what an "agent" actually is, how agents should look and act, and how users should interact with them. The field is large and confusing, and several attempts have been made to try to structure the research through taxonomies, frameworks, and research summations [16, 6, 9].

As interaction designers, we are particularly interested in exploring the visual form of human and non-human agents. We define form as the shape, materials, expression, and behavior of a particular artifact, service, or system. The visual form can be defined as the static appearance of a particular agent at a given time. Currently, most agents in research prototypes are one-off designs that have not been systematically designed with any particular criteria in mind. As a result, we believe that it is not clear when any one representation, such as a human, humanoid, or animal are appropriate in a real product.

Catrambone et al. offer a valuable framework that outlines the need for knowledge about the intersection between agent form (visual, voice, interaction method, …), features of the user (personality, gender, goal, …), and agent task (application domain, intent, focus/context, …) [4]. Our study advances their work by further detailing the relationship between agent visual form, agent task, and user demographic . In examining the previous work on embodied agents' visual forms we have identified the following issues: (i) the connection between task and the visual form of an agent rarely exists; (ii) The software agents used in studies often perform tasks that are unfeasible or awkward for agents to conduct in the "real world"; and (iii) most studies have focused on behavioral findings with respect to software agents and have infrequently offer design implications or been used to generate design knowledge.

Additionally, the Apple's Guides project, a user interface for a multimedia database containing an historical encyclopedia, is an example of the strong effect of agent form on the user experience. From previous research on hypertext interfaces, the developers knew that users often became disoriented while following links between documents. To address this problem and to link the interface design to its historical

content, they chose an interface metaphor of "guides": black and white renderings of people in historical dress. While they expected the guides to reduce the cognitive load of the navigation task, the effect on the interface was quite different. Users experience strong *presence* for these grainy, still images and began to view the content not as an encyclopedia of facts but instead as the personal perspective of the selected "guide" [17].

2.1 Research on Agent Form

People interact with computers—the physical devices—as if they were social actors, even when not represented with textual dialog, a voice, or an anthropomorphic form [20]. Adding an agent with a visual form accentuates this effect by making the goal of personification more specific and by allowing the designer to be more explicit in the character and role they want the computer to play. The aspects of visual form, including costume, gesture, and facial expression, provide designers with "semiotic shortcuts" that other interaction methods cannot provide [8]. Agents that take visual form in an interface also explicitly communicate a brand and set of company values. While the benefits of embodied agents have been shown in several studies, many in the field take issue with their use. We are not concerned with the arguments for or against their use; rather, our assumption is that embodied interface agents are already being used and will continue to be used in the future.

One of the earliest studies by Walker et al. on people's reactions to embodied agents asked participants to take a survey about computer support with experimental conditions that included a text interface, a talking face with a neutral expression, and a talking face with a stern expression [21]. They found that the use on an onscreen created an increased sense of presence. Additionally, the use of the stern face inspired more detailed responses to the survey but also creates a less enjoyable experience.

In further exploration, Koda and Maes conducted a study where participants played poker with agents that used different visual forms including a photorealistic man and woman, a cartoon man and woman, a cartoon dog, a smiley face, and an invisible player [13]. Prior to completing the task, participants rated the visual form of the photorealistic faces of the man and woman as more intelligent, likeable and engaging than the cartoon faces. After playing poker this effect disappeared, and participants found the photorealistic faces to be more comfortable than the cartoon faces and the smiley face, and the visual form of the smiley face to be best suited to the poker playing task.

Parise et al. conducted two studies to explore how people cooperate with embodied agents [18, 19]. Participants played a game with an agent partner where cooperation with the agent produced a reward and deception produced an even higher reward. If both the participant and the agent tried to deceive each other, neither got a reward. Making an agent look more like a real human, rather than a cartoon, was found to increase levels of cooperation between subjects and agents. However, no differences were found in people's reaction to or cooperation with a cartoon dog as compared to 3D computer rendering of a dog. This indicates that the effect of improving the quality of visual form might play a larger role for human-looking agents than for non-human ones.

Similarly, Dryer conducted a study looking at how agents express personality by asking participants to rate 37 animated characters [9]. No difference was found in the ratings of 3D rendering as opposed to cartoons. Note, while these findings relate to visual appearance, they are disconnected from task.

Catrambone et al.'s study extends the connections between task and agent form [4]. Participants were asked to work with an agent to select items needed for a trip and to edit a document. Participants interacted with a 3D animated face, a 3D static face, and a cartoon drawing of a light bulb. Differences between the human and non-human forms could not be separated from the different agent tasks.

Finally, in a pilot study conducted by Cowell and Stanney, they found that participants preferred agents that looked young and agents whose appearance matched the ethnicity of the user [5].

In summary, these studies show that the rendering quality and rendering type of the visual form of an agent—photorealistic, cartoon, etc.—plays only a small role in shaping the user experience. What seems more important than the image quality is the relationship between the agent's form and task and the relationship of the form to individual users.

2.1.1 Human and Non-human Forms

In designing an embodied agent, designers often choose between human and non-human visual forms. Several studies have explored people's reactions to each. King and Ohya asked participants to rate 20 different visual forms of agents ranging from simple geometric shapes to wire frames of humans to detailed 2D and 3D human forms [12]. Participants found the human forms to have more presence than the non-human, abstract forms. However, it is important to note that the participants rated only the visual form; they did not interact with the agents or have any sense of the task the agent might perform.

Animals have also been a common choice for the visual form of an embodied agent. Several studies have explored differing reactions between human agents and agents that appear as dogs. In Koda and Maes' experiment using the poker-playing task, participants rated the dog more likeable and engaging than the human agent before playing the game; however, after playing poker they rated them all the same [13]. The role of the agent as an opponent in a poker game shaped the experience more than the visual form.

One of the main issues in comparing human and non-human visual forms revolves around user expectations of the intelligence of the agent. Many researchers have speculated that human forms give a false expectation of intelligence, and that users will be disappointed when the agents do not deliver on the implicit promise [15,12]. King and Ohya addressed this issue directly by asking users to rate intelligence, and found that human-looking agents were perceived as more intelligent than abstract agents [12]. The Koda and Maes study [13] and the Parise et al. studies [18, 19] all found that people initially rated the dog agent as less intelligent, but changed their ratings based on the interaction with the system. These findings support the claim that the visual form of the agent can initially influence the perception of intelligence, but that the task the agent performs also plays a critical role in shaping users' perceptions.

Finally, in the Parise et al. cooperation studies, the researchers noticed that across all users, participants cooperated with dog form less than the human form [18, 19]. However, when they looked at the behavior of users who owned a dog, the discovered these participants showed no difference in cooperation between the human and dog visual forms. Clearly the experience of owning a dog shaped the participants expectations of interacting with an agent that took a dog's form.

2.1.2 Gender

Surprisingly little research has been done to explore gender differences with respect to agents. Even though gender stereotypes exists in society at large, current research has found few differences in how men and women perceive agents and how people perceive male and female agents.

Koda and Maes found no difference in perceptions of intelligence, likeability, and engagingness between visual forms of male and female agents [13]. However, when they divided participants into two pools based on whether they *agreed* or *disagreed* with the idea of anthropomorphism in computer interfaces, the researchers found that in the "Agree" pool, participants found the male agent to be more intelligent and more likeable. Additionally, the "Disagree" pool found the female agents to be more intelligent and likeable, but the finding was not statistically significant. A later study by Cowell and Stanney investigated the use of non-verbal communication by embodied agents [5]. In this study, which used only female participants, participants selected male and female looking agents nearly equally to help them with a photo-sorting task.

Other research has found no differences in how men and women rated agents [9]. Catrambone et al. found that 54% of the female participants used a personal pronoun (he/she) to refer to an agent, while only 13% of the male participants used a personal pronoun [4]. This finding suggests there may be a difference in the way men and women personify agents. Our study, reported in the next section, found a difference both in people's preference for male and female agents across a range of tasks and in men and women's overall preference for agents.

3 PCAM Study on Visual Form of Agents

Our analysis of the previous research on embodied agent's visual forms helped us to envision the interaction designer's task of creating an agent's visual from as being quite similar to a casting director's job of casting actors for specific roles. People's expectations for the visual form of the agent were clearly influenced by the task the agent performed and by the social and cultural experiences of the user. With casting, the casting director not only considers role but also the audience that will be viewing the show. With this conceptual model in mind we wanted to address what we see as a gap in the research by exploring the relationships between the visual form of an agent, the task the agent performs, and the gender of the user. To do this we decided to conduct a PCAM (Product Content Analysis Method), which aids designers in evaluating their intuition by more clearly revealing the connections between visual form and

other factors. The PCAM has been conducted to assist with the design of walkers and humanoid robot heads [7, 10].

We began our exploration of agent form by collecting, assessing, and sorting a large number of agent examples. Our goal was to elicit the design primitives implicit in the work of previous agent designers. We collected color images of current agents in isolation, void of context, and at an angle that clearly shows all aspects of the visual form. We anonymized the agents by removing visible logos and affiliations. We scaled them to the same relative size in order to better compare them against each other. After an initial comparison, we eliminated agents with duplicate features, reducing the set to 24 (Fig. 1). We found it quite difficult to find examples of human agents that did not look white, and age was also indeterminate, so therefore race and age were not features.

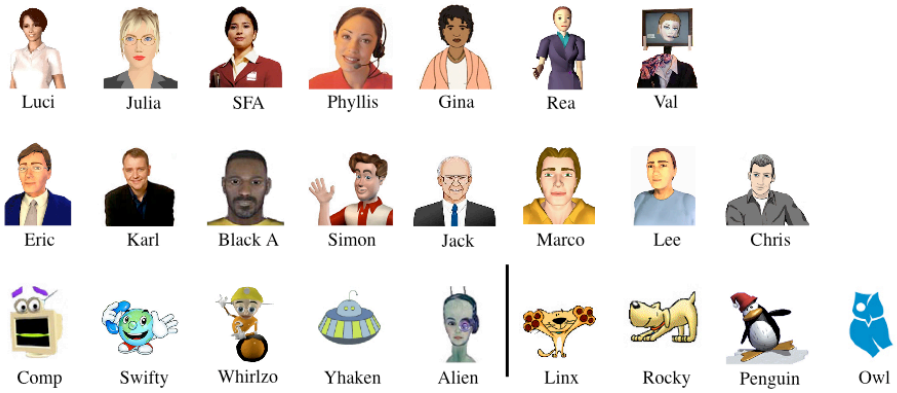

Fig. 1. Visual form of agents rated by participants. Names were not used in the study.

The visual design and design features within them were derived from the 24 examples and are not all-inclusive. We expect that design features will be added to the list as they are catalogued from the ongoing collection of agent examples, and that new groups of design features may emerge in future studies.

The agents were grouped according to style and appearance, and sorted by similar design features. From these sorting activities, we generated a Features List and Code Book, focusing on five feature sets of the anthropomorphic agents.

- **Instantiation:** human, animal, other
- **Persona:** name, gender, unknown
- **Rendering:** photographic, cartoon, photorealistic
- **Features:** eyes, nose, eyelids, hair, glasses, etc.
- **Facial Expression:** happiness, surprise, sadness, fear, anger, disgust, interest, neutral

We then coded each agent on each feature dimension for the presence or absence of features. This resulted in a 24-agent x 42-design feature matrix.

We deployed the PCAM as a web survey where participants rated each of the 24 agents across 15 tasks. Tasks were selected based on the Strong Campbell Interest Inventory [3], Laurel's four categories of suitable agent roles [14], and a review of agent literature. This review produced over 30 roles/tasks. We reduced this to a set of 15 tasks for embodied agents that could be understood in the physical world, being careful to avoid personal pronouns and the word "person" in the name (Table 1).

Table 1. Agent tasks.

Task Classification	Tasks
Entertainment and Social	museum tour guide
	vacation planner
	concierge
	matchmaker
Information	reference librarian
	movie recommender
	real estate agent
	laboratory technician
Work	receptionist
	financial advisor
	customer service representative
	medical advisor
Learning	Therapist
	athletic trainer
	tutor

Participants ranged in age from 19 to 57, with a median age of 28. 36 were female, 27 were male, and one did not indicate sex. Participants viewed the 24 agents in random order and provided ratings for each of the 15 tasks using 5-point Likert scales in response to the statement, "This agent would make a good:" where 5 is "highly likely" and 1 is "highly unlikely". Participants never saw the agent's name.

3.1 Results

An initial analysis of the collected responses revealed the following four main results:

1. Participants rated agents with human visual forms significantly higher than agents with non-human visual forms.
2. Participants rated agents with human-female visual forms significantly higher than agents with human-male visual forms.
3. Male participants rated agents with human visual forms significantly higher than female participants.
4. The task the agent performs influences the both the visual form users prefer as well as the personification of the agent.

Table 2. Summary of agent comparison t-test results.

Agent Comparison	Mean x	Mean y	Difference	p-value
Human forms to non-humans form across all participants	2.840	1.747	1.093	2.2e-16
Human-female forms to human-male forms across all participants	3.163	2.729	0.434	2.2e-16
Animal forms to other forms across all participants	1.854	1.701	0.153	3.07e-10
Male participants to female participants for all agents	2.581	2.331	0.25	2.2e-16
Male participants to female participants across all agents with human forms	3.040	2.698	0.342	2.2e-16
Male participants to female participants across all agents with non-human forms	1.809	1.720	0.089	0.0006

We performed a series of t-tests to check for statistical significance. Table 2 summarizes the results. Note that for row three we removed Lee and Val for this t-test. Based on the pattern of participant responses, it seems clear that users did not consider the androgynous Lee to be male or Val—the robot with a video screen head—to be female. Also note that for the last row, while the results are statistically significant, the small difference in means (1.809 and 1.720) indicates the difference may not be practical.

Table 3 provides the mean satisfaction ratings for individual agents in rank order (mean score for all participants: "Combine Ave"). The "Agent Class" column details the agent classification (human-female: "Hu-Fe", human-male: "Hu-Ma", "Animal", and "Other"). Columns "Female Part" and "Male Part" detail the mean satisfaction scores for male and female participants. Highlights in these columns reveal where the ratings are statistically significant ($p < .01$). The "Not Given" column displays the mean satisfaction scores for the one participant who did not indicate a sex.

Table 3. Mean satisfaction scores across agents and by participant sex

Visual Form	Agent Class	Female Part	Male Part	Not Given	Combine Ave
Luci	Hu-Fe	3.315	3.704	2.667	3.469
Julia	Hu-Fe	3.233	3.766	2.667	3.449
SFA	Hu-Fe	3.104	3.514	3.733	3.286
Eric	Hu-Ma	3.006	3.321	3.000	3.139
Phyllis	Hu-Fe	3.018	3.304	2.400	3.129
Karl	Hu-Ma	2.741	3.454	2.667	3.041
Gina	Hu-Fe	2.746	2.995	3.267	2.859
Rea	Hu-Fe	2.654	2.981	2.200	2.785
Chris	Hu-Ma	2.518	2.916	2.533	2.686
Blk A	Hu-Ma	2.593	2.829	2.200	2.686
Jack	Hu-Ma	2.533	2.704	3.200	2.616
Simon	Hu-Ma	2.415	2.864	1.600	2.592
Marco	Hu-Ma	2.272	2.447	2.200	2.345
Val	Hu-Fe	2.360	2.214	2.867	2.307
Lee	Hu-Ma	1.959	2.552	1.533	2.203
Swifty	Other	2.057	2.089	1.000	2.054
Comp	Other	1.828	1.912	1.133	1.852
Linx	Animal	1.823	1.852	1.000	1.822
Whirlzo	Other	1.612	2.074	1.000	1.797
Rocky	Animal	1.713	1.825	1.000	1.749
Yhaken	Other	1.728	1.765	1.000	1.733
Penguin	Animal	1.700	1.675	1.133	1.681
Owl	Animal	1.552	1.583	1.000	1.556
Alien	Other	1.458	1.512	1.267	1.478

Fig. 2 offers additional detail on participants' ratings based on the agent's classification and the participant's sex. Like table 2 above, the chart has been sorted by highest mean for all participants. Notice that (i) human agents were preferred over non-human agents, (ii) female agents were preferred over male agents, and (iii) men preferred agents more than women. An asterisk in front of an agent name indicates agents where the ratings difference between female and male participants is statistically significant. Note: this difference appears for most human agents but only for one non-human agent (Whirlzo).

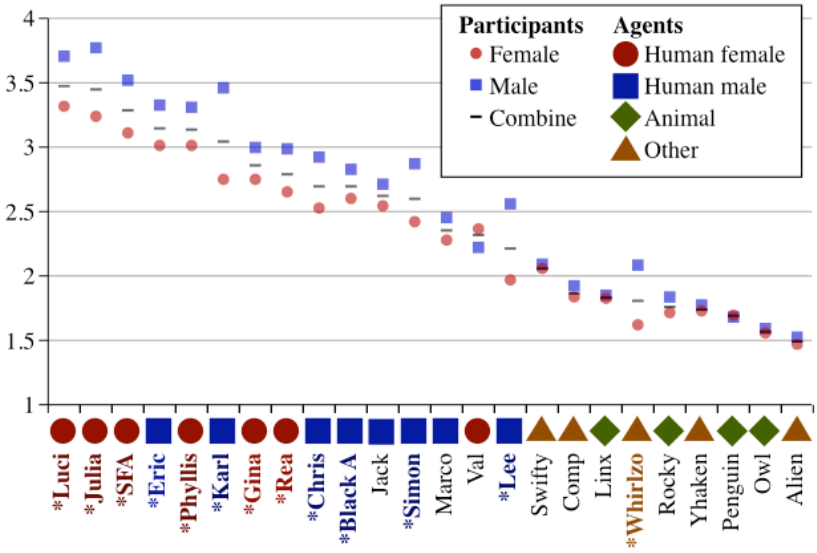

Fig. 2. Mean satisfaction scores for agents detailing participant sex and agent classification.

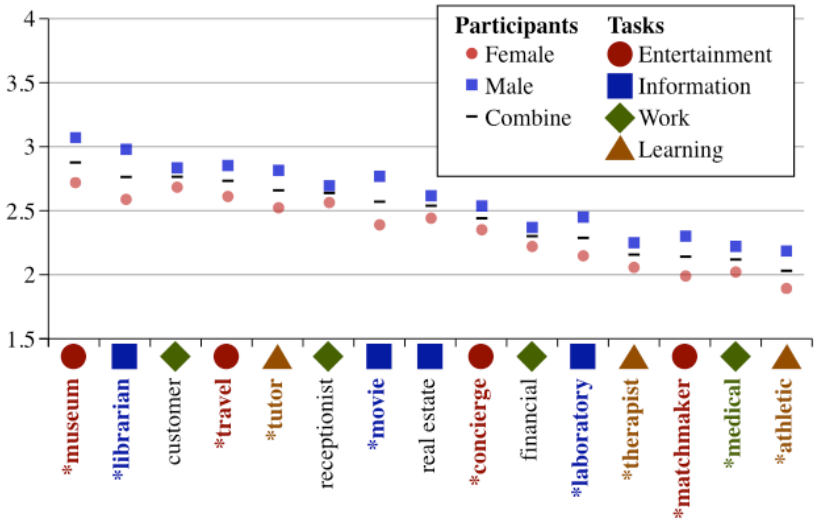

Fig. 3. Mean satisfaction scores for male and female participants across agent tasks.

Fig. 3 displays a plot of mean satisfaction scores for male and female participants across the different agent tasks sorted by the highest combined score. Notice that male participants gave higher scores for all tasks than female participants. An asterisk in front of a task name indicates where the ratings for male participants and female participants for an individual task are statistically significant ($p < .01$).

Table 4 and Fig. 4 display the mean satisfaction score for each agent form across the different tasks. In Fig. 4, notice that for some tasks, the split between the human and non-human agent scores is quite wide. A vertical gray line that spans from the non-human agent average rating to the human agent average rating indicates this split. For the tasks real estate, customer service, and financial advisor, the difference in ratings is more than 3 points from a scale of 1 to 5. And for the tutor and movie recommender, the difference between human and non-human is approximately 1. Athletic trainer and movie recommender are the only tasks where a male agent scored significantly higher than a female agent. Highlights in Table 4 and an asterisk in front of a task name in Fig. 4 indicate where the ratings for male agents and female agents for an individual task are statistically significant ($p < .01$).

Table 4. Mean satisfaction score for agent instantiation across agent tasks

Task	Hu-Fe	Hu-Ma	Other	Animal	Combine Average
Museum	3.488	2.832	2.401	2.304	2.875
Librarian	3.504	2.643	2.347	2.040	2.764
Cust Srv	3.771	2.921	1.836	1.644	2.760
Travel	3.549	2.759	2.156	1.747	2.732
Tutor	2.890	2.779	2.243	2.308	2.650
Receptionist	3.767	2.397	1.956	1.750	2.633
Movie Rec	2.545	2.864	2.151	2.308	2.564
Real estate	3.401	2.927	1.462	1.341	2.533
Concierge	3.157	2.592	1.713	1.613	2.442
Fin Advisor	2.939	2.738	1.369	1.253	2.299
Lab Tech	2.687	2.536	1.845	1.415	2.286
Therapist	2.685	2.490	1.268	1.407	2.150
Matchmaker	2.621	2.260	1.430	1.696	2.135
Med advisor	2.599	2.464	1.339	1.286	2.113
Ath trainer	2.022	2.738	1.234	1.399	2.030

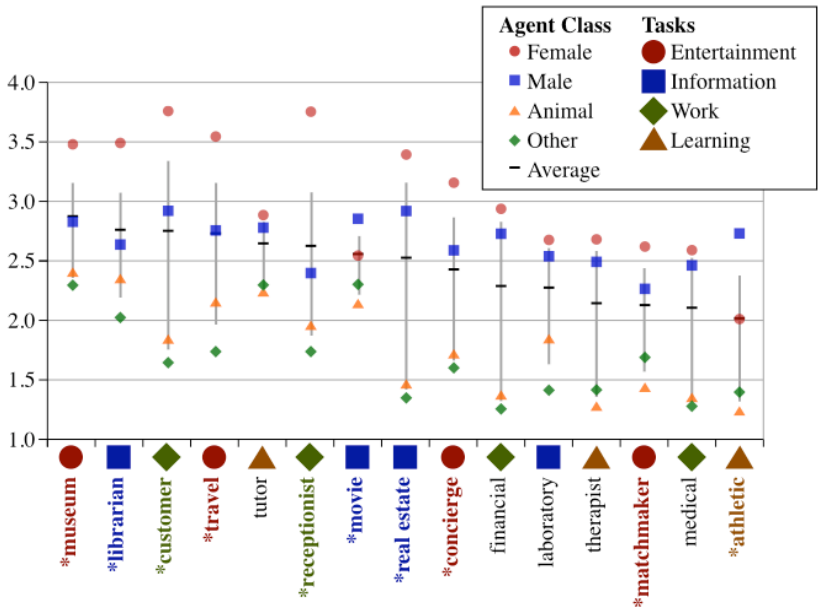

Fig. 4. Mean satisfaction score for agent instantiation across agent tasks

3.2 Discussion

3.2.1 Preference for Human Looking Agents

Participants clearly preferred agents with human forms. Fig. 2 shows that none of the non-human agents was liked more than Lee, the lowest rated agent with a human form. This finding makes sense in that previous research has shown a strong link between the agent form and task, and for our PCAM study, we selected tasks people can easily imagine themselves doing with other people.

3.2.2 Preference for Female Looking Agents

From the previous research on agents and gender had shown few results. However, in taking a casting approach to agent form, it makes sense that different tasks would be viewed as more male or more female. Our findings support the notion that gender stereotypes found in society at large do play a role in shaping people's expectation of agent form. Participants clearly made a link between the support tasks the agents could perform with the gender stereotype of women playing more supporting roles. The stereotype theory helps explain the higher rating of the female agents for receptionist, realtor, and librarian. The higher rating for the male athletic trainer can also be

explained by gender stereotypes as men are often viewed as having a stronger connection to athletics. Again, this finding supports the argument of strongly connecting the visual form of agents with the task they support and the role they play.

3.2.3 Men's Preference for Agents

Previous research did not predict any differences between men and women's reactions to agents. Only the Catrambone et al. study had found a difference—that women used personal pronouns to describe agents more than men—[4], and this finding seems to indicate that women would be more comfortable with personification than men. However, the higher ratings given by men seem to tell a different story. This cannot be easily explained by men's overall stronger interest in interacting with computers, because male and female participants expressed the same preference for the non-human agents. What it does point to is a difference in the way men and women personify agents that take on human forms, and this issue clearly requires further exploration.

3.2.4 Agent Task and Form

The desire for human looking agents varies by task. Interestingly, the tutor and movie recommender tasks had the smallest difference in preferences between human and non-human forms. It may be that people have already begun to think of computers performing these tasks, do not have a strong mental image of a person in this task (movie recommender), or have had no or no recent interaction with a person that performs this task (tutor). The human agent preference for the financial advisor task was more surprising given the mathematical task this agent performs. However, this may have something to do with feelings of privacy and risk that surround financial transactions. This along with the strong preference for human customer service agents may have more to do with a desire for presence, a desire to feel that the system or service is really listening to the user.

4 Design Implications

The results of our PCAM study, along with the findings from the previous research, help to reinforce our concept of relating the design of an embodied agent's visual form with casting. All the results indicate strong relationships between the preferred visual form, the agent tasks and the social roles they relate to, and the social and cultural makeup of the user. With this model of "casting" the agent's visual form in mind, we offer the following design implications

1. Casting the agent as human, animal, or other

Not all agent tasks map the directly to social roles people understand. In selecting whether to use a human, animal, or iconic form, designers need to consider how

closely people relate the specific task the agent performs to transactions they have experienced with people in the real world. If users have no clear mental model of a human in the role, such as a movie recommender, it creates a better opportunity to deviate from the use of a human form. Additionally, in casting an agent form, designer should consider the emotional undercurrents of the human-agent transactions. Are they private, serious, entertaining, professional, etc.? These undercurrents influence the tone users expect and therefore the form they prefer. Finally, designers need to consider the many different social and cultural experiences users bring to the transaction. Use this as a guideline in casting a form to match the target user's expectations of the social role the agent fills.

2. Casting for and against stereotypes

The gender stereotypes people have for individual tasks and social roles clearly influence their preference for agent form. In casting an agent, designers need to consider whether to play into or play against a stereotype. This choice will affect the overall tone of the transaction and will begin to reflect back on the user's perception of the underlying product/service and the company that provides it. What are the underlying messages about values that the company wishes to communicate, and how does playing into or against the stereotype aid in this communication? In addition to gender stereotypes, we expect that the stereotypes users have also include race and age as well as language and behavior.

3. Opportunities for recasting

In designing transactions between embodied agents and people, interaction designers should look for opportunities to recast the agent's visual form. Apple's Guides interface offers a model where the agent's visual changed across the content [17]. In addition to content, we recommend that designers consider both the transition points within an agent's tasks and social and cultural diversity of the users. Many agents perform a variety of tasks. In considering recasting, designers should cluster the tasks around different social roles. In this way the agent can change form as the tasks change, allowing it to best match the current transaction. Additionally, when opportunities arise where the system knows something about the user before an embodied agent is introduced, the system can select a form that best matches the social and cultural expectations of the specific user as opposed to having one form for all users.

5 Conclusion and Future Work

Embodied interface agents continue to transform the experience of interacting with computers and with the services they provide, making the experiences more social by explicitly referencing human-to-human interactions. Recent advances in technology that make agents "smart" and more realistic looking, as well as the movement of computing into more and more social domains, has created more opportunities for interfaces with embodied agents. Through a review of previous research on agent form along with our on study, we found strong relationships between the visual form of an agent, its intended task, and the experience and expectations of different users.

This has led us to conceive of designing the visual form of an agent as a type of "casting". With this concept in mind we encourage interaction designers working on embodied agents to consider (i) the relationship between the agent task and the user's experience of this task as a human to human transaction; (ii) how they should address the strong influence of stereotypes that connect the expectation of agent form, the agent task, and the experience of the user, and (iii) opportunities for recasting based on breakdown of different tasks a single agent performs and based on knowledge of individual users.

Years ago, Laurel stated that "In terms of design, the meatiest problem is developing criteria that will allow us to select the appropriate set of traits for a given agent—traits that can form coherent characters, provide useful cues to users, and give rise to all of the necessary and appropriate actions in a given context." [14] Today, Laurel's words remain a motivation for us in exploring the design of embodied interface agents.

In the future, we plan to further this work in two ways. First, we plan to continue our analysis of our current dataset, exploring in more detail the relationship between the 24 different forms and the 15 different tasks. In addition, we plan to increase the scope of this work to also include transactions with disembodied agents: agents that interact through text or voice but offer no visual form.

6 Acknowledgments

This material is based upon work supported by the Defense Advanced Research Projects Agency (DARPA) under Contract No. NBCHD030010. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Defense Advanced Research Projects Agency (DARPA), or the Department of Interior-National Business Center (DOI-NBC).

References

1. Ananova: http://www.ananova.com/
2. Bartneck, C.: Interacting with an Embodied Emotional Character. Proceedings of the DPPI (2003) 55-60.
3. Campbell, D., Crichton, L., Hansen, J.I., Webber, P.: A New Edition of the SVIB: The Strong-Campbell Interest Inventory. Measurement and Evaluation in Guidance 7(2) (1974) 92-95.
4. Catrambone, R., Stasko, J., Xiao, J.: Anthropomorphic Agents as a UI Paradigm: Experimental Findings and a Framework for Research. Technical Report GIT-GVU-02-10. Georgia Institute of Technology (2002)
5. Cowell, A.J., and Stanney, K.M. "Manipulation of non-verbal interaction style and demographic embodiment to increase anthropomorphic computer character credibility," International Journal of Human-Computer Studies, 62 (2005) 281-306.
6. Dehn, D.M., van Mulken, S.: The Impact of Animated Interface Agents: A Review of Empirical Research. International Journal of Human-Computer Studies 52(1) (2000) 1-22.

7. DiSalvo, C., Gemperle, F., Kiesler, S., and Forlizzi, J.: All Robots are Not Created Equal: The Design and Perception of Humanoid Robot Heads. Proceedings of DIS (2002) 321-326.
8. Don, A.: Anthropomorphism: From Eliza to Terminator 2. In Proceedings of CHI (1992) 67-70.
9. Dryer, D. C.: Getting Personal with Computers: How to Design Personalities for Agents. Applied Artificial Intelligence, 13 (1999) 273-295.
10. Gemperle, F., Powers, A., DiSalvo, C., Forlizzi, J., and Kiesler, S.: Product Content Analysis Method Applied to Walkers. White Paper, Carnegie Mellon University (2004)
11. Iams: http://www.iams.com
12. King, W. J., Ohya, J.: The Representation of Agents: Anthropomorphism, Agency, and Intelligence. In Proceedings of CHI (1996) 289-290.
13. Koda, T., Maes, P. Agents with Faces: The Effect of Personification. Proceedings of IEEE Workshop on Robot and Human Communication (1996) 189-194.
14. Laurel, B.: Interface Agents: Metaphors with Character. In (Eds: Laurel, B.): The Art of Human-Computer Interface Design, Addison-Wesley (1990) 355-365.
15. Maes, P.: Agents that Reduce Work and Information Overload. Communications of the ACM 37(7) (1994) 31-42.
16. Middleton, S. E.: Interface Agents: A Review of the Field. Technical Report ECSTR-IAM01-001, University of Southampton (2001)
17. Oren, T., Salomon, G., Kreitman, K., Don, A.: Guides: Characterizing the Interface. In (Eds: Laurel, B.): The Art of Human-Computer Interface Design, Addison-Wesley (1990) 355-365.
18. Parise, S., Kiesler, K., Sproull, L., Waters, K.: My Partner is a Real Dog: Cooperation with Social Agents. Proceedings of CSCW (1996) 399-407.
19. Parise, S., Kiesler, S., Sproull, L., and Waters, K.: Cooperating with Life-Like Interface Agents. Computers in Human Behavior, 15 (1999) 123-142.
20. Reeves, B., Nass, C.: The Media Equation: How People Treat Computers, Television, and New Media Like Real People and Places. Cambridge University Press (1996)
21. Walker, J. H., Sproull, L., Subramani, R.: Using a Human Face in an Interface. Proceedings of CHI (1994) 85-91.