Agents as Artists: Automating Socially Intelligent Embodiment (Extended Abstract)

Sheryl Brahnam

INTRODUCTION

The whole application of the fine arts to the representation of men is based on the principle that the minds of those who are represented may be indicated by their forms.

Paget, *Quarterly Review*, 1856

It is not surprising that artists are typically given the task of designing the physical appearance of embodied agents. Media artists are skilled at exploiting the physical characteristics of their characters for artistic effect. In the popular media, good guys and bad guys, intellectuals and bumbling idiots, are immediately recognizable. This is because the morphology of bodies and faces is inscribed with social meaning.

In this paper we argue that agents should take over the job of the artist and learn to create their own socially meaningful embodiment. We focus on the face as it forms the locus of many of our social interactions and cultural experiences [1]. A number of researchers have begun to investigate the cultural aspects of faces for agents [2]. One area that has received considerable attention concerns facial expressiveness [3, 4, 5], especially as it enhances the believability of the agent. The face, however, is a complex communication system where transitory signals, such as emotional displays, facial posturing, and other behaviors, modulate a morphology that is also pregnant with meaning. As Bruce [6] has remarked, when shown a face, not only are we prepared to judge a person's emotional state, but also their "personality traits, probably employment and possible fate." Visual artists use this morphology as a language for rapidly communicating all this information and more about the characters they are portraying.

In order to enable agents to create faces with clear cultural meanings, it is important to understand how people express and read meaning into facial morphology. Towards this end, an overview of some of the literature on the trait impressions of the face is provided along with some examples illustrating the artistic use of this material. After reviewing the relevant psychological literature on the person perception of the face, we present two techniques for generating faces that produce specific impressions. Finally, we reflect on how this technology can be employed to enhance user interactions with embodied agents.

THE PERSON PERCEPTION OF THE FACE

Although several theories have been advanced to explain why certain facial characteristics consistently elicit specific impressions [7], one major theory is that the perception of facial features has adaptive value and that those characteristics that have the most influence on impression formation are based on those characteristics that demand the greatest attention for the survival of the species [8]. As Zebrowitz [9] explains, "We could not function well in this world if we were unable to differentiate men from women, friends from strangers, the angered from the happy, the healthy from the unfit, or children from adults. For this reason, the tendency to respond to the facial qualities that reveal these attributes may be so strong that it is overgeneralized to people whose faces merely resemble those who actually have the attribute." Two of the most significant overgeneralization effects are the attractiveness halo effect and the facial maturity overgeneralization effect.

The Attractiveness Halo Effect

Our culture is not unique in encouraging its members to alter the appearance of their faces. Although religious motives and a need to mark social status are factors motivating facial elaboration in other cultures, enhancing the esthetic appeal of the face is paramount. It is popularly believed that social benefits accrue to those who are most attractive, and current research supports this claim. People respond positively to attractiveness and associate it with positive character traits. Attractive people are considered more socially competent, potent, and intellectually capable than those less attractive. They are also perceived as being psychologically better adapted [10]. Facial abnormalities and unattractiveness, in contrast, elicit negative responses and are associated with negative traits. Unattractive people are considered less socially competent and willing to cooperate. They are also considered more dishonest, unintelligent, antisocial, and psychologically unstable. Negative reactions to unattractive people are also more severe [11].

What are the morphological characteristics that make a face attractive? To date there is no theory of attractiveness that is generally accepted, even though there is evidence of a strong consensus in judgments of attractiveness, cross-culturally, cross-racially, and even across species [12]. Contemporary research into facial attractiveness indicates that straightness of profile, proportion, symmetry, and closeness to the average (with the average being computed arithmetically, using the pixel values of facial images) are some important factors in attractiveness judgments [13, 14].

Of particular interest is the relation of profile shape to judgments of attractiveness, as profile shape is also associated with facial maturity. Margo [15] believes a preference for a straight profile is related to a preference for derived features generally. Derived features are those that have

developed out of the recent evolutionary changes of bipedalism, enhanced intelligence, reduced sexual dimorphism, manual dexterity, and an omnivorous diet. Derived features are rated more beautiful than older, more primitive features. Margo believes that Barbie is so popular precisely because her face and body exhibit these as well as many other derived features. Features that are atavistic, e.g., a prognathic profile (characterized by a chin extending noticeably beyond the nose), are generally judged to be unattractive.

The Overgeneralization Effect of Facial Maturity

Perhaps no face is more capable of eliciting a favorable response than that of a baby's. Humans and animals alike are disarmed and entranced by a youthful face. The favorable response to a baby's face is not just reserved for babies, however, but is generalized to adults whose faces resemble those of babies [9]. Babyfaced individuals are universally attributed child-like characteristics. They are perceived to be more submissive, naïve, honest, kindhearted, weaker, and warmer than others. They are also perceived as being more helping, caring, and in need of protection. Mature-faced individuals, in contrast, are more likely to command respect and be perceived as experts.

The morphological characteristics that mark a baby's face are large eyes relative to the rest of the face, fine, high eyebrows, light skin and hair color, red lips that are proportionally larger, a small, wide nose with a concave bridge, and a small chin. Other significant age related differences in faces concern developmental changes in craniofacial profile shape. Of particular note are differences in the relative size of the brain capsule and the slant of the forehead in relation to the chin. The infantile cranium is proportionally much larger than the fully mature cranium, and the infantile forehead protrudes whereas the adult forehead recedes. Another important characteristic of facial maturity is a dramatic increase in jaw size.

Facial maturity plays a significant role in artistic characterization. A good example of the use of facial maturity to reflect character is seen in the evolution of two famous cartoon characters: Mickey Mouse and Bugs Bunny. Mickey Mouse has grown progressively younger as his personality has become more charming and endearing [16]. The size of his head has grown larger in proportion to his body. His eye size has also increased. Bugs Bunny's head, in contrast, has grown smaller in proportion to his body. His eyes have also narrowed. The physical maturity of his face and body reflects a change in his character. Over the years Bugs Bunny has grown more abrasive and clever.

TECHNIQUES FOR AUTOMATING SOCIALLY MEANINGFUL FACES

There are two techniques for automating socially intelligent embodiment for agents that we believe are particularly promising. The first method would alter faces employing the cardiodal strain transformation developed by Todd and Mark [17]. Applied to standard profile shapes, this transform has been shown to approximate real growth. Furthermore, studies on the trait attributions of profiles that vary in the degree of cardioidal strain applied are consistent with findings on facial maturity [18]. As craniofacial profile maturity decreases, so do perceived alertness, reliability, intelligence, and strength. Moreover, infantile profile shapes are more lovable, less threatening, and elicit stronger desires to nurture and protect. Applying the transformation in the direction of extreme facial maturity produces the atavistic prognathic profile. Atavistic faces have long been used by artists to portray flawed or immoral characters [1].

Alternately, face classification techniques could be used to model specific trait impressions of the face. We are currently investigating the use of Principle Component Analysis (PCA) [19], or equivalently a linear autoassociative neural network, to classify faces along nine social dimensions: dominance, emotional maturity, intelligence, sociality, psychological adjustment, warmth, trustworthiness, attractiveness, and facial maturity [20]. A major advantage of using PCA is that it could provide agents with a means of *perceiving* faces in terms of the impressions they make. Although it may be possible to synthesize novel faces with a high probability of producing specific impressions from within the PCA face space [21], a perceptual system could enable agents to select facial forms for itself that elicit predictable responses when using other methods of face synthesis.

APPLICATIONS

We are, it holds, thoroughly social, so that when we gaze at other's faces, we see not revelations of soul, character, or emotion but declarations of their intentions towards us, and reflections of ours towards them

Fridlund, *Human Facial Expression*

Providing agents with the means of perceiving and generating faces in terms of the impressions they make would offer some unique advantages. Outlined below are some reflections on how this technology might be employed.

Smart Face Interfaces

A number of studies in the person perception literature show that people rely on facial impressions when trying to make sense of ambiguous statements or actions [22]. It is reasonable to expect that people will use the facial appearance of embodied agents when an agent's actions are confusing due to limitations in its ability to understand and interact socially. An agent's face will either clarify its actions and intentions or further complicate them. As anyone needing directions in an unfamiliar city knows, some people look more approachable then others. If an agent is given the task of assisting others, it could advertise its function by generating a face people would automatically be willing to approach. If an agent is expected to offer advice or function in a recommender system, it could alter

its features so as to look convincing. If an agent is in a situation where it could be abused or attacked, it could learn to adjust its face to limit user abuses. Just as people learn to control the impressions their faces make, so agents could learn to prepare social masks that are suited to their tasks.

Social Self-Awareness and Mirroring

Endowing agents with the ability of perceiving and generating faces along certain social dimensions provides the agents with a rudimentary sense of social self-awareness. This awareness could grow as the agent adapts its physical self within a social world and learns from its failures and successes. Furthermore, a perceptual system would enable agents to participate in the evaluation of others. People spend a significant amount of time not only gossiping about others but also worrying about what others are saying about them. Agents that could read faces could also function as private social mirrors. Imagine an agent that could provide honest, albeit delicate, answers when asked how old, attractive, intelligent, or trustworthy the user appears.

Language Driven Facial Compositing

As mentioned above, we are currently examining the possibility of categorizing and generating faces that fall within a few trait categories. It may be possible to extend the trait vocabulary in such a way as to provide users with a method of rendering faces using verbal descriptors. Mapping faces to verbal descriptions could prove useful in applications, such as forensic facial compositing, where users are required to reproduce or alter facial images.

Entertainment

Furnishing users with a natural verbal means of manipulating faces along social lines could also prove entertaining and enable users to participate in the creation of avatars, dolls, and game characters. In game applications, agents could use this technology to generate physical forms for themselves that are designed to mislead or affect players in ways that enhance the user's enjoyment of the game. Automating socially intelligent embodiment could also prove particularly useful in generating crowd scenes composed of unique individuals that nonetheless reflect a consistent character type.

Awareness Training

There are social implications in exploiting some common negative facial stereotypes. Rather than perpetuate facial stereotypes, agents could actively counter facial profiling by probing the user's largely unconscious and unjustified responses to certain facial configurations.

RELEVANCE

Research conducted by both academia and industry indicate that interface design is evolving towards more person-alized interfaces. Communication with the user is increasingly being mediated by embodied agents [23]. As is the case with human beings, there is every reason to expect that users will search an agent's physical form for clues regarding its character and intentions. Rather than rely on artists to furnish agents with suitable embodiment, the state-of-the-art in computer graphics today is such that agents could easily generate their own physical forms. Haphazardly creating an appearance, however, could be counter productive. Our work explores the social meanings inscribed in the morphology of embodiment and examines methods that would provide agents with the ability of intelligently manipulating their own morphology in ways that could enhance human-computer interaction.

REFERENCES

[1] Magli. P. The Face and the Soul. Feher, M., Naddaf, R., and Tazi, N., Eds. Fragments for a History of the Human Body, 2, 86-127. Zone, New York, 1989.

[2] Sproull, l., Subramani, R. Kiesler, S., Walker, J.H., and Waters, K. When the Interface is a Face, Human-Computer Interaction 11 (1996), 97-124.

[3] Elliott, C. D. Multi-Media Communication with Emotion-Driven "Believable Agents." Presented at AAAI Spring Symposium on Believable Agents 94 (1994).

[4] Perlin, K. Real Time Responsive Animation with Personality. IEEE Transactions on Visualization and Computer Graphics 1, 1 (1995), 5-15.

[5] Perlin, K. Layered Compositing of Facial Expression. ACM SIGGRAPH 97 Technical Sketch, (1997).

[6] Bruce V. Recognising Faces. Lawrence Erlbaum Associates, Publishers, Hove and London, 1988.

[7] Albright, L., Malloy, T. E., Dong, Q., Kenny, D. A., and Fang, X. Cross-Cultural Consensus in Personality Judgments. Journal of Personality and Social Psychology. 72, 3 (1997), 558-69.

[8] McArthur, L. Z., and Baron, R. M. Toward an Ecological Theory of Social Perception. Psychology Review 90, 3 (1983), 215-38.

[9] Zebrowitz, L. A. Reading Faces: Window to the Soul? Westview Press, Boulder, CO, 1998.

[10] Langlois, J. H., Kalakanis, L., Rubenstein, A. J., Larson, A.., Hallam, M., and Smoot, M. Maxims or Myths of Beauty? A Meta-Analytic and Theoretical Review. Psychological Bulletin 126, 3 (2000), 390-423.

[11] Bull, R., and Rumsey, N. The Social Psychology of Facial Appearance. Springer-Verlag, New York, 1988.

[12] Cunningham, M. R.. Measuring the Physical in Physical Attractiveness: Quasi-Experiments on the Sociobiology of Female Facial Beauty. Journal of Personality and Social Psychology 50, 5 (1986), 925-35.

[13] Perrett, D. I., Burt, D. M., Penton-Voak, I. S., Lee, K. J., Rowland, D. A., and Edwards, R. Symmetry and Human Facial Attractiveness. Evolution and Human Behavior. 20, 5 (1999), 295-307.

[14] Langlois, J. H., Roggman, L. A., and Musselman, L. What Is Average and What Is Not Average About Attractive Faces? Psychological Science 5. 4 (1994), 214-20.

[15] Magro, A. M. Why Barbie Is Perceived as Beautiful. Perceptual and Motor Skills 85,1 (1997), 363-74.

[16] Gould, S. J. Mickey Mouse Meets Konrad Lorenz. Natural History 88, 5 (1979), 30-36.

[17] Todd, J. T., and Mark, L. S. The Perception of Human Growth. Scientific American 242, 2 (1980), 132-44.

[18] Alley, T. R. Infantile Head Shape as a Elicitor of Adult Protection. Merrill-Palmer Quarterly 29 (1983), 411-27.

[19] Turk, M. A., and Pentland, A. P. Face Recognition Using Eigenfaces. Presented at IEEE Computer Society Conference on Computer Vision and Pattern Recognition, Silver Spring, MD (1991).

[20] Brahnam, S. Creating Physical Personalities for Virtual Agents with Faces by Modeling Trait Impressions of the Face: A Neural Network Analysis. The Graduate Center of the City of New York, NY, Ph. D. Dissertation (2002).

[21] Beymer, D., Shashua, A., and Poggio, T. Example Based Image Analysis and Synthesis. MIT, Cambridge, MA, A. I. Memo 1431 (1993).

[22] Hochberg, J., and Galper, R. E. Attribution of Intention as a Function of Physiognomy. *Memory and Cognition 2,* 1A (1974), 39-42.

[23] Biocca, F. The Cyborg's Dilemma: Progressive Embodiment in Virtual Environments. Journal of Computer-Mediated Communication, 3, 2 (1997).