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Visual realism and virtual pedagogical agents

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Published in:
Proceedings of the 3rd International Design and Engagability Conference @ NordiChi 2006 (iDec3)

2006

Link to publication

Citation for published version (APA):
Haake, M., & Gulz, A. (2006). Visual realism and virtual pedagogical agents. In J. Knight (Ed.), *Proceedings of the 3rd International Design and Engagability Conference @ NordiChi 2006 (iDec3)*
http://wwwold.eat.lth.se/Personal/Magnus/default_eng.htm

Total number of authors:
2

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To be presented at the *Int. Design and Engagability Conference @ NordiCHI 2006 (iDec3)*, October 14-18, Oslo, Norway.

Visual Design of Virtual Pedagogical Agents: Naturalism versus Stylization in Static Appearance

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ABSTRACT
The paper presents an overview of arguments for and against visual naturalism in virtual humanlike agents, with a focus on pedagogical settings, concluding that there is: (i) a need for a distinction between static and dynamic qualities in the visual appearance of virtual agents; (ii) little general support for visual naturalism in virtual humanlike agents; and (iii) a definite need for more empirical research on the issue and on user effects of visual aspects in general. Furthermore, the paper analyses how contrasting perspectives towards visual naturalism are related to differences in research practices and research goals.

Keywords
HCI, virtual pedagogical agents, visual style, appearance, design spaces, realism, naturalism, stylization, research motives.

ACM Classification Keywords
K.3.1 [Computer Uses in Education] Computer-assisted instruction (CAI).

INTRODUCTION
Virtual pedagogical agents, i.e. computer generated characters in pedagogical roles[1] are entering the digital society in increasing number. They are found in educational programs, from preschool to university. They are also found in wider educational contexts, as virtual medical counsellors, physical exercise coaches and guides on city homepages as well as in edutainment and infotainment settings.

An aspect that has been surprisingly little researched regarding virtual pedagogical agents is their *visual appearance* in terms of facial shape, body and costume, graphical style, etc. In the literature design choices with respect to visualization of agents are rarely problematized [9,10].

Yet, the evidence that many basic patterns from human-human interaction recur in human-computer interaction [23] gives reason to pay more attention to these issues, as it is well established within social psychology that humans are profoundly affected – in terms of behavioural responses as well as beliefs and attitudes – by the visual appearance of others.

The present paper focuses on *visual naturalism* versus *visual stylization*, which is a fundamental design dimension with (major) consequences for the overall visual experience [9,10]. We start out by defining the concepts and their contexts. Thereafter we present and analyze arguments for and against visual naturalism. Next, we discuss how contrasting approaches towards visual naturalism in virtual pedagogical agents may be related to differences in research practices and research goals. Finally, based on our findings, we suggest a research agenda.

VISUAL DIMENSIONS

Static and Dynamic Visual Appearance
First of all, we want to make a distinction between static and dynamic visual appearance. Underlying any animation in terms of gestures, facial expressions, speech, gaze, etc., there is a basic, inanimate figure with given visual properties such as graphical style, body and face shape, clothes and attributes, colours and textures. These initial properties constitute the static qualities of the agent's visual appearance. When these qualities are brought to life by scripts and algorithms invoking gestures, speech, gaze, etc., we encounter the dynamic qualities of the agent's appearance. Together the static and dynamic qualities add up to the total visual experience.

[1] The article focuses on virtual agents for educational use, but much of what is said is applicable on virtual agents in many other contexts as well.

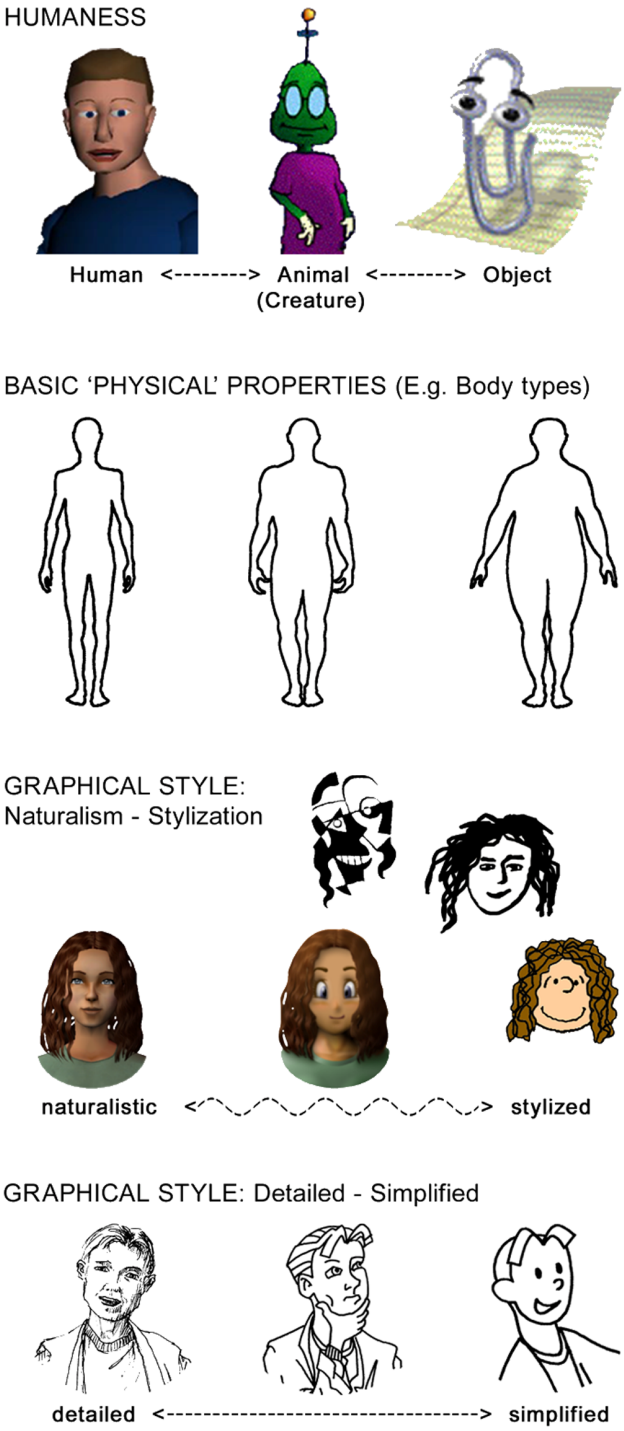

Figure 1. Dimensions of 'Static Visual Appearance'.

Visual Static Dimensions

Given this distinction between static and dynamic visual appearance, the next step is to look closer at the visual static design space. Having considered different approaches to handle visual aspects [e.g. 3,6,19], we single out the following design dimensions (see also Figure 1).

- Humanness: An agent can basically be modelled upon humans, animals (or other creatures), and nonliving objects – or some combination of these three entities; in figure 1 exemplified by three well-known agents: *Steve* (© CARTE, University of Southern California), *Herman the Bug* (© IntelliMedia, North Carolina State University), and the *Office Assistant (Clippit)* (© Microsoft Corporation).
- Basic 'physical' properties (Shape and Colour): For a humanoid agent, as an example, there are basic 'physical' properties, such as body-type, face, colour and type of skin, hair, clothes and various attributes.
- Graphical style: The graphical style of an agent's appearance relates extensively to artistic qualities, and there are several ways to describe these properties.[2] For the purpose of virtual agents, two dimensions are of particular interest.
  - *Naturalism vs. stylization*: This dimension is complex, with especially the stylized alternatives spanning over a wide range of different styles or expressions. The diversity can be exemplified by considering a character from *The Sims* representing near naturalism and e.g. a Picasso-styled face or a *Peanuts* inspired face representing two different stylized expressions. Note that there is no simple, linear relations in the design space of naturalism – stylization.
  - *Detailedness vs. simplification*: Referring to the examples above, especially the photo can be referred to as detailed. By means of reduction it might be turned into a semi-detailed (and semi-naturalistic) contour drawing. It might also be more dramatically transformed into a very simplified (and stylized) cartoon. Note, thus, that a naturalistic representation can be more or less detailed.

In the above presentation the 2D vs. 3D dimension is deliberately left out as a dimension in its own right. The reason is that: (i) 2D and 3D can be handled as different expressions (or visualizations) within the design space of naturalism vs. stylization[3].; and (ii) 3D is basically the possibility to interact in a 2D-simulation of 3 dimensions (unless maybe using virtual reality equipment like helmets and gloves) It is principally possible, though it would certainly look quite silly, to inhabit a 3D-environment with

[2] The dimensions of graphical style in this paper can be compared to The Picture Plane, visualizing the graphical design space of comics, as proposed by Scott McCloud [19].

[3] In line with the analysis of Ruttkay et al. [24].

simplified, flat comic figures (and scenes) without volume – looking as thin lines when viewed from the side.[4]

We will in the following focus on human-like agents (cf. the humanness dimension) and especially present and discuss arguments and evidence for and against 'naturalism' (based on the naturalistic – stylized dimension) in static visual appearance of virtual pedagogical agents. However, this is easier said then done, as research and development mostly have neglected to distinguish static and dynamic visual qualities. As a consequence, arguments and evidence concerning static aspects are seldom explicitly stated, but have to be extracted from arguments around dynamic aspects.

ARGUMENTS FOR VISUAL NATURALISM

The Smooth Communication Argument

A common argument in favour of a high degree of naturalism in virtual pedagogical agents emphasizes the fact that in human-human interaction we are predisposed to exploit information from human gestures, facial expressions, eye movements, etc. This is, furthermore, known to considerably increase the smoothness of interaction [4,15]. Thus, by endowing a computer-based agent with gestures and facial expressions that are as human-like as possible, human–computer interaction will also become efficient [6]. This is an obvious argument for using theory and models based on human–human interaction in psychology and linguistic as a source to closely model the human–computer system on the human–human system. However, there are two issues to ponder: (i) To what extent does this argument bear on static visual appearance? (ii) Are there alternative approaches to achieve (as much) smoothness in human–computer interaction?

Smooth Communication and Naturalism

If we begin with considering the *linguistic performance* of virtual agents, there is much support for the value of naturalism (or, as it is often spelled out, realism). Even though human voice/speech can vary considerably in dialect, tone, intonation, etc., there is not much of tolerance for any deviation from a human 'naturalistic style'. If the voice/speech is ever so little synthetic or otherwise odd, the response will most often be negative [18].

Turning to *dynamic visual appearance* in the sense of bodily behaviour the degrees of freedom as to user responses increase considerably. Although a certain degree of correlation with naturalistic movements is required (robot-like movements in non-robots could, for instance, have a negative impact) human beings are used at perceiving a lot of rather stylized movements in animated movies and computer games [6]. In *The Illusion of Life: Disney Animation*, a canon of animation, the "fundamental principles of animation" are described, e.g. "squash & and stretch", and "exaggeration" [25, p.47]. There is of course a connection between linguistic performance and dynamic visual appearance – especially as to the face and the mouth. Nevertheless, one can exaggerate face and mouth movements and even occasionally make them grotesque, as long as there is a basic synchronization with the speech [25].

Thirdly, as to *static visual appearance*, it seems as if 'almost anything works'. Very small cues trigger our acceptance of something as representing a (humanlike) person, and especially a face (Figure 2). We seem to automatically (and happily) apply our social responses and attitudes in approaching this 'something' [19,23].

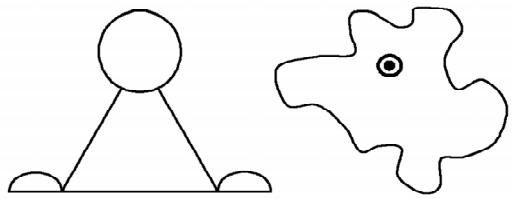

Figure 2. A human can easily be perceived from a few simple lines or shapes. Likewise, place 'a circle with a dot' anywhere inside almost any shape, and you have a face [18, p.32].

Our point is that these three 'levels' – linguistic performance, dynamic visual appearance and static visual appearance – are quite different as to human interpretations and tolerance of naturalistic versus stylized representations. Many arguments 'pro realism', however, do not separate the levels but treat them as 'a unit'. In particular, arguments for realism in linguistic behaviour and/or dynamic visual appearance seem to just let static visual appearance go along, instead of treating it as something to consider in its own right. It is treated as 'the surface' rather than 'the foundation for the animation' [9]. Thereby, a (reasonable) strive for realism in some aspects ends up in a non-reflected striving for overall realism.

An illustrative example is presented by Gustavsson & Czarniawska [11]. At a conference presentation the development team of the interactive assistant Olga (Figure 3), described a conflict between the linguists and the visual designers within the team: "The linguists insisted that in order for Olga's speech to be understood, she must be made as human-like as possible. Her lip movements, in particular, had to correspond to those of a living human." [11, p.8]. Therefore, the comic styled alternative presented by the visual designers was turned down in fa-

[4] Actually, there are several examples of visual jokes in movies where the actors (usually by accident) turn into 2-dimensional flat figures (e.g. [29]).

vour of a more naturalistic 3D-rendered representation of Olga. The designers, on the other hand, were of the opinion that the comic styled Olga was much more human-like and attractive than the more naturalistic 3D-Olga, who they thought looked like Frankenstein's monster, an opinion shared by most of the conference audience. But, as Gustavsson & Czarniawska [11, p.8] put it, "The linguists remained unruffled in their belief in mimetic representation.". The discourse on 'visually naturalistic' is also interesting. In our view, none of the Olgas (Figure 3) is 'naturalistic'. Instead they constitute two different visually stylized representations. This indicates that the notion of naturalistic/realistic sometimes is more of a non-reflected idea than an actual and explicit visual quality ('If it's 3D, it's realistic!'). All in all, the example above illustrates that qualities of visual appearance is a delicate and complex issue.

Figure 3. The two Olgas: Left: the comic styled Olga; Right: The 3D-rendered Olga.

Similar conflicts as the one just related turn up every now and then due to a misguided grouping together of levels – not acknowledging that a certain degree of naturalism in visual dynamic appearance does not require the same degree of naturalism in visual static appearance, and that, in particular, naturalism in linguistic behaviour is practically independent of naturalism in visual static appearance.

Alternatives to Visual Naturalism for Obtaining Smooth Communication

Are there alternatives to visual naturalism in the static and dynamic appearance of agents for obtaining communicative gains such as effectiveness and smoothness? As pointed out, by Gratch et al. [6, p.2] 'media', in a broad sense, has developed a wide range of "stylized presentation styles" with which most people have "[…] considerable experience interacting with that (arguably) have greater communicative efficiency than face-to-face interaction." Accordingly, professionals like actors and animators are extremely knowledgeable about different visually stylized presentation styles that deviate markedly from normal, naturalistic human appearance and behaviour. This is also in line with Laurel [16], who in her comparison between virtual characters and theatre characters points at their central function as a shorthand for understanding and predicting behaviour, rather than representing full-blown personalities – where also the *appearance* of a character ought to be represented in such a way that it suggests its internal traits to the user. In theatre, heavy make-up and large distance to the scene reinforces the appearance of artists on the scene as visually stylized. The same applies to gestures and mimics as these often are stylized in terms of simplification and exaggeration – resulting in improved communication with the audience. A distinct example can be found in the classical Chinese opera, where dresses and make-up, as well as gesturers, are heavily stylized. Notably, Lewis Johnson, an experienced opera singer himself, in [14] speculates on whether *voice* in animated agents ought to be based on naturalistic face-to-face conversation or rather in some way stylized.

In graphic design and advertisement we find many successful examples of manipulations of graphical style to both convey information and trigger consumption. A simple example against visual naturalism as an obvious goal for effective communication is the overwhelming popularity of *smileys* to clarify and underline the messages in e-mail and sms. Another striking example is the popularity of Manga, with Manga styled graphics now also appearing in advertisement.

Also in the domain of computer games there is a strong Japanese tradition that lifts forth the communicative advantages with stylized – often Manga inspired – characters. With stylization it is easier to recognize a character, or a kind of character, by only glancing at it. Such quick understanding and identification of a character on the basis of its visual appearance, is considered an important value. Also for dynamic appearance the values of stylization are emphasized: when a character strikes a special pose, one should be able to tell who it is by the pose alone, in parallel to poses used in the kabuki theatre [13].

An implication of all this is that the potentials of stylization should be more seriously considered in the design of virtual pedagogical agents: both in the design of the underlying, visually static, models for faces, bodies, costumes, etc; and in the design of dynamic qualities such as gestures, facial expressions, gaze, and possibly speech.

The Identification Argument

Much of the motivation for introducing virtual pedagogical characters lies in their potential to take advantage of natural human social affordances [8]. It is well known that social elements are important in the interaction between a student and a human instructor [1,8], and therefore of interest to reproduce these aspects. Accordingly, it seems reasonable to attempt to closely emulate human beings in

order to recreate phenomena that we know work and are pedagogically valuable in the human–human context, such as collaboration, emotional support, and intellectual challenge.

One pedagogically central phenomenon is how human teachers, instructors, and mentors can function as role models [1]. Now, the efficiency of a role model is known to increase when a student experiences similarity with the role model and this may be taken as a pretext that pedagogical agents ought to be as realistically similar to human beings as possible. Because how could one otherwise identify with the role model? How could one create those social bonds that are held to be crucial for learning outcomes with sketched or cartoon-based characters? Surely, the preconditions for this must be superior in the case of a figure that looks really like a human being.

The above line of reasoning has an intuitive appeal, but empirical evidence does not support it. Actually, it seems that people quite easily form relationships to, and identify themselves with, iconic (stylized) characters. Studies by Gulz & Haake [8,10] indicate that when learners were allowed to make a choice between (i) more naturalistic versus more stylized visual representations of virtual pedagogical agents, as well as between (ii) strictly task oriented communication versus more socially oriented communication in the agents – there was a significant correlation between the preferences for socially oriented agents and a stylized visual representations of the agents. An interpretation of this result is that stylized agents are more easily conceived of as subjective and personal than naturalistic agents. This interpretation is in line with comic specialist McCloud's thesis [19] that it is easier to identify with an iconic (stylized) than a realistic (naturalistic) character. A highly naturalistic (realistic) agent is a visual and socio-emotional fact, which does not leave much for a user to fill in. It is objectively there, whereas a stylized (iconized) agent invites elaboration by the user, who may fill in and create out from his or her own personal and subjective experiences. In McCloud's [19, p.36] wordings, the stylized (iconized) character is "[…] an empty shell that we inhabit". Additional support in this direction comes from Nowak & Biocca's [22] study, involving relatively naturalistic versus heavily stylized characters in VR-environments. Here users rated the stylized characters significantly higher than the naturalistic ones as to their experience of a psychological connection with the character, in terms of co-presence and social presence.

The Believability Argument

Believability has, not without reason, become a key notion in discussions of virtual agents even though it is a rather vague notion. Johnson [15] argues that in Virtual Reality and other immersive environments, "[…] a realistic appearance is important both to increase believability and to give the agent a greater ability to demonstrate skills." [15, p.6] and sets as a goal to increase the realism of appearance in face and figure (as well as behaviour) of several existing pedagogical agents. Comparing this to the earlier referred suggestions of Johnson [14] on the potential value of stylization, we draw the conclusion that the arguments in [15] are conditioned and particularly refer to the immersive environment context. However, we believe that the value of naturalistic visual appearance of agents is an open question also for this kind of context [cf. 28]. Furthermore, it may also be questioned whether the ability to demonstrate skills necessarily improves with increased visual naturalism. For example, imagine an instruction video for demonstrating the skills required to replace parts in an engine. Here, a clear and clean 2D-animation could be more useful than a detailed, naturalistic 3D-rendering with disturbing shadowing effects and confusing details – or, on the extreme, a fully naturalistic video showing a blurred black-brownish mess of moving hands, engine parts, grease, dirt, and oil. In such a situation there is probably truth in the expression "less is more". At the same time we agree upon the need of naturalism in applications as *The Mission Rehearsal Exercise Project* [15] (by Johnson and others) where the basic concept is to prepare soldiers for a complex, messy, contradictory, and unpredictable reality.

An argument for visual naturalism related to believability that appears now and then states, that visual naturalism is required to indicate that something is serious, whereas stylization signals leisure and especially entertainment. In response to this, we consider it an open, empirical question what kinds of effects that different forms of visual static appearances may have in this respect, and to what extent they may vary between user groups and application settings (see Figure 4). In any case, an absolute relation between 'stylization' and 'entertainment' is highly unlikely given all the *kinds* of different visual styles that are comprised within the group of stylized representations.

Figure 4. There are many examples of stylized graphical information being used in serious settings.

In sum, our contention is that *believability*, in most interpretations of the term, does not require visual naturalism in appearance.

ARGUMENTS AGAINST VISUAL NATURALISM

The previous section discussed a number of arguments *in favour of* visual naturalism. Our conclusion is that empirical evidence does not support the arguments, and although there are contexts where the naturalistic approach does seem plausible, it is more often questionable or even contra productive. The next section proceeds towards arguments *against* visual naturalism.

The False Expectations Argument

If a virtual agent in its visual appearance naturalistically resembles a human being, we will also expect the agent to behave as a human being and in particular as intelligently as a human being. But such expectations are rarely fulfilled.

This is perhaps the most frequently proposed argument against visual naturalism in agents. The argument assumes that a conflict between the abilities of an agent and the learners' perception of these abilities, can cause frustration in the learner and that, as Dowling [5], referring Masterton [17], argues "[t]he more visually realistic the representation, the higher the expectations of the user in relation to the appropriateness and 'intelligence' of utterances and actions […] many users […] express a higher tolerance of the limitations of a 'character' that is more sketchily represented, for instance through cartoon-like graphics" [5, p.30]. Likewise, Dehn & van Mulken [4] review studies indicating that agents with a more naturalistic visual appearance can indeed hamper learning by suggesting misleading behaviours.

Now, this argument can of course be countered as applying only to temporary state of affairs. Mismatches between naturalism in agents' appearance and user perceptions of their knowledge level as revealed through behaviour, use of language, etc., occur because of the immaturity of current systems. In future and more advanced systems, theses shortcomings will vanish and give way to naturalism and human-likeness in both appearance and behaviour. It is indeed hard to object to this. But it is likewise hard to object to the argument that we at present and in the foreseeable future run a definite risk to create such false expectations if we work with fully naturalistic visual appearances in virtual agents. Wages et al. [27] argue against visual realism as a goal for computer games also in the long run. Increasing the degree of visual naturalism in any category of stimuli, will, according to 'the stimuli interdependency paradox', increasingly reveal the shortcomings in terms of naturalism in other categories of stimuli. The 'recognition of reality' in one category of stimuli will awake peoples' 'wardens of reality' and make them more critical (cf. the 'uncanny valley' phenomenon recognized by Masahiro Mori [21]).

Also compare Hall et al.'s [12] pragmatic statement that the use of cartoon characters "[…] offers a technical safety net in that highly naturalistic behaviour is not expected in cartoons making the element of jerkiness natural to experimental software less of an issue" and adds that "[…] the cartoon metaphor already provides design decisions that most cartoon-viewing children accept naturally" [p.4].

Regarding expectation clashes, we find it worth noting that there are *other* inconsistencies that may cause clashes than those between humanlike, naturalistic, appearance versus constrained, non-human-like, behaviour. Also mismatches between a high-quality stylized static appearance and (i) awkward animations or (ii) awkward language and behaviour can cause irritation. In general, preciseness is called for in studies on (in)consistency. As an example Vinayagamoorthy et al. [26] make use of (i) two algorithms for eye movements to exemplify 'higher-realism' and 'lower-realism' behaviour, and (ii) two visual characters to exemplify high and low visual realism. (In our terminology, a visually more naturalistic and considerably more stylized visual character.) Results were that the visually high-realism character was scored higher together with the high-realism behaviour and the visually low-realism character scored higher together with the low-realism behaviour. The authors take this to support the principle of a desired consistency in behavioural and visual realism. However, there are two problems with this. First, and to some extent acknowledged by the authors, eye movements are a very specific kind of behaviour in communicative contexts. Second, one of the *visual details* that were varied plays a very specific role as regards eye movements, namely *eye size*. The more naturalistic character has 'normal' sized eyes, whereas the eye size of the stylized character is much exaggerated. Now, it is likely that such large eyes must *move* considerably more in order not to be experienced as *staring*. Without a complementary study involving a stylized character with 'normal' eye size it seems impossible to pinpoint the (in)consistency in question. The results may tell more about the relation between two different eye movement algorithms and relative eye size, than about the relation between eye movement realism and visual realism.

The 'Problem of Representing Perfection' Argument

In traditional non-interactive media such as TV, video and magazines, the promotion of idealized super people with 'perfect' bodies and looks (and lives) is prominent. With computer media this portraying of the ideal – the perfect face, the perfect body, the perfect behaviour – can be taken one step further. Stereotypic instances never found in real life (no matter how much cosmetic surgery), may be pre-

sented, such as the big-breasted, thin-waisted, action heroine Lara Croft – a biological contradiction.

It can be argued that this phenomenon already exists in comics. The key difference, though, lies in what is otherwise seen as one of the main potentials of virtual characters – not the least in pedagogical terms – namely the interactivity: Virtual characters may communicate, respond, answer – and this, in turn, may pose a danger in that the 'distance' between users (learners) and these 'ideal super people' will diminish. Until now we have watched and read about these fabulous, good-looking people in movies and magazines. If we, now, are also to interact with them – in an era already desperately pursuing perfection in appearance – this might have detrimental effects on peoples self image and self esteem. And more so, it can be argued, if the characters are very naturalistically rendered. Because as long as they are not, it may be easier to maintain an attitude of 'this is another kind of creature that I do not have to match or compete with'. A counter argument to this line of reasoning can, however, be found in McCloud's thesis that subjective identification with a cartoonish character comes much easier than with a realistic character [19]. Also compare Reeves & Nass' [23] studies which indicate that human beings do not 'keep a distance' even to the most ersatz representations of a person. This is clearly an area for further empirical investigations.

Another argument against visual naturalism that relates to perfection is the recognition that naturalistic visual appearances may give a too perfect and cold impression, which can be unfortunate and undesirable if the goal of a virtual agent is to provide a pleasing impression [7].

Summing up, arguments in favour of as well as against visual naturalism are complex, and it does not seem possible to maintain an altogether clear stance towards stylization versus naturalism. Nevertheless, we will in the coming section put forth a preliminary approach. First we sort out some different motives behind the conflicting arguments around visual naturalism. Thereafter we present a preliminary agenda.

RESEARCH AGENDA

Sorting Out Motives

The most commonly stated motive behind research and development around pedagogical characters is probably that of obtaining a smooth and beneficial interaction between humans and computers in pedagogical contexts. With respect to this motive, the following must be made clear: It cannot be taken for granted that the most valuable interaction between humans and computers is, or will ever be, via virtual characters that are visually indistinguishable from human beings. It is just as likely that the most enjoyable, efficient, smoothest and beneficial interaction will be with visually stylized characters – especially what concerns the visual static qualities.

But another motive behind the development of virtual pedagogical agents is that of more specialized research within disciplines such as linguistics, psychology, and communication science, aiming towards the scientific modelling, theorization, and ultimately understanding of human activities and behaviour, of 'what constitutes the human' (human dialogues, human voices, human gestures, human facial expressions, and so on). Character based electronic environments are, in this context, a powerful research tool and an eminent laboratory for exploring these processes and phenomena [2]. Virtual characters that behave like humans in a certain aspect, while implemented according to a particular theory on that human aspect, is an interesting test-bed for the theory. Now, aiming at understanding interaction and communication between humans by studying and implementing interaction and communication between humans and virtual characters entails an aim at emulating real humans as closely as possible – including naturalism in visual appearance – as a self-evident goal.

Much of the knowledge stemming from research and development according to this latter motive is – besides being valuable in its own scientific right – fundamental for the development of usable working virtual pedagogical agent applications. However, from the more pragmatic perspective of the former motive, there is a sometimes wide gulf between a theoretical modelling, focusing on naturalistic human behaviour and a pragmatic approach focusing on the development of a usable and working system (maybe even without any agents or advanced modelling). As Gratch et al. [6] hold forth, virtual pedagogical characters are, from a pragmatic approach, tools that must efficiently fulfil roles in an overall system, and with design characteristics subordinate to the overall goals of these systems.

In sum, some of the conflicting stances towards naturalism vs. stylization in virtual agents originate in confusions between the *goals* or *motives* behind the development of virtual agents. Distinguishing more clearly between the scientific modelling of naturalistic human behaviour and the pragmatic approach focusing on the development of a usable tool is necessary. Only this way will we be able to benefit fully both from the potentials of virtual pedagogical agents as powerful test-beds for theoretical modelling and from their pedagogical potentials.

Agenda

Several of the arguments for and against naturalism vs. stylization in the underlying static model of virtual pedagogical agents require systematic research in order to provide us with more reliable guidelines. Furthermore, such

research is imperative, as it concerns phenomena that are central from a pedagogical point of view. On the basis of the discussions in this article we would like to emphasize:

- Role modelling: What are the potentials and effects with visually naturalistic versus stylized agents?
- Identification: (How) do identification effects differ between visually naturalistic versus stylized agents?
- Idealization: How does perfection in appearance (looks) affect users when the agent is visually naturalistic versus stylized?
- Stereotyping: How does visual style (naturalism versus stylized) relate to visual stereotypes – and how can we benefit from this relation?

Increased knowledge on these issues would enable more deliberate design choices regarding the visual appearance of virtual pedagogical agents than we find today.

ACKNOWLEDGMENTS

The authors are grateful for the financial support of the Swedish Research Council, VR.

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