Researching virtual environments and characters

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In a broad sense a virtual environment is when something – a book, a film, or a computer game – makes a human being experience another environment than the one she is physically situated in. In a narrower use of the term, some form of digital technology lies behind the experience in question. There is a variety of technologies that can be used to create or manipulate perceptual information to make people associate it with another environment than the physical environment they are situated in. For the most powerful virtual environments, people can hardly differentiate which environment is "real" – the virtual or the physical. But in the more common case people very well know, on a reflective level, that the virtual environment they act in or respond towards is *not* "the real one". Nevertheless they act and react *as if* it was. They are engaged in the virtual environment and experience a kind of *being there*. In this respect there is no absolute difference between, for example, a virtual environment generated from an ordinary desktop-computer game and one generated from more powerful Virtual Reality technology (such as in Fig. 1a).

Fig. 1. Examples of virtual environments: (a) In *Eon Icube*, computer-generated images are projected on walls and floor and a head tracker gives information about the position of the head of users to make each eye see the right perspective; (b) *Virtual Annelöv* is a reconstruction of a Swedish Bronze Age settlement, that makes experiences of this historical period of time possible by virtual role plays (Benigno, 2005); (c) The virtual guide *Cosmo* inhabits a virtual environment that visualizes parts of the Internet (Lester et al., 1999).

Virtual environments are used for a variety of purposes, and I will relate some of the major ones here. One purpose is to train for dangerous environments and situations (e.g. parachute jumping or fire-fighting operations). Another is to visualize and simulate environments in scientific and/or educational contexts (e.g. planet simulations or historical simulations as in Fig. 1b.). A third major application domain is health and medicine (health counselling, rehabilitation and therapy, communication training with virtual patients, surgery training, to give a few examples). A fourth important context is education in a broad sense. Apart from simulations/visualizations, there are virtual role plays for language training or leadership training, and a variety of other kinds of learning environments that allow learners to work extensively with material at their own pace.

A central aspect of virtual environments is *virtual characters*. These are computer-generated, more or less humanlike animated characters, encountered for example as virtual instructors or learning companions, virtual counsellors, characters in role plays, or web guides.

This chapter focuses on *character-centred virtual environments*. I start with an overview of different kinds of virtual characters and a presentation of their main properties: virtuality, humanlikeness, interactivity, and socio-emotional affordances. With this as a background I then go into two main cognitive science perspectives on virtual characters:

1. *Virtual characters as objects of research*: Studying the effects that virtual characters and our interacting with them have and can have on us as socio-cognitive creatures.

2. *Virtual characters as research instruments*: Using them to explore human beings as communicating and interacting beings.

1 Virtual characters – sorts and kinds

1.1 Notions

There are a number of notions besides *virtual character*, such as: *virtual agent*, *synthetic character*, *embodied conversational agent*, or *interface character*. Roughly, *agent* is more often used when one wants to underline a character's autonomy and intelligence (based on artificial intelligence in a wide sense).[1] *Character* is a broader term used to incorporate the whole variety of visual, computer-generated, more or less humanlike artefacts.

One can also distinguish the following two main groups: Avatars, which are directly controlled by a human being who uses the character as a representation of herself, versus characters that are not controlled by a human being in this way but act more autonomously. This chapter deals primarily with the latter group.

Yet two more types of virtual characters are relevant for the text: *embodied conversational agents* and *affective agents*. *Embodied conversational agents* (*ECAs)* are characters where the focus is on conversational abilities (Ruttkay & Pelachaud, 2004). "Embodied"

[1] *Agent* in a computer-technology sense denotes a *computer program* that can "act" on its own (i.e. autonomously). *Virtual agent* refers both to the visual gestalt and character that the user/human being encounters and to the modules and models behind this, which may consist of a set of *agents*, in the computer-technology sense.

signifies that the character has a visual gestalt or body used for communication by means of speech/voice/sound, facial expressions, gestures, and other aspects of body language. *Affective agents* (Burleson et al., 2004) are virtual agents with capacities to detect, interpret and/or generate emotionally related information. They can be part of systems that exploit physiological data (heart rate, skin conductance, etc.) and/or tone of voice to assess the affective state of a person (bored, confused, engaged, etc.) in order to adapt system output thereafter. In other words, these are virtual agents with capacities to respond to users' emotional states and reactions, and to "express" their own emotions on the basis of models of (human) emotions. A sub-set of affective agents are *relational agents* (Bickmore, 2003) designed to develop and maintain long-term, socio-emotional relations with users. Such agents can, for instance, have a form of "memory" of past interactions with a person, and be based on models of how relations between human beings develop over time.

Fig. 2. Examples of virtual characters: (a) Characters from a virtual role-play for anti-bullying teaching for school usage (www.e-circus.org); (b) A virtual instructor and a virtual training partner with whom to train greetings, farewells etc. according to a foreign culture (Babu et al., 2007); (c) The *iCat* robot from Philips, which can play parlour games; (d) A variety of virtual pedagogical agents for instructing, coaching and mentoring, from RITL (Center for Research of Innovative Technologies for Learning, Florida); (e) A virtual coach for support in health-related daily behaviour (Bickmore, 2003; 2007; Bickmore & Pfeifer, 2008); (f) A virtual ambassador for university level engineering programmes (Gulz et al., 2007b).

1.2 Properties of virtual characters

Virtual characters are, thus, used in many contexts, and come in many forms. They vary as to:

– The *extent of similarity* to a real human (or some other animal) in their appearance and behaviour

– Which *degree of interactivity* – possibilities for mutual influences – between human and character is possible

– The *complexity and kind of models* that generate and control them

– On what level of detail their behaviour is already *pre-rendered* versus on what level it is *generated in real time* depending on input from a user interacting with them

– Which *communicative modalities* are used for input and output: speech, text, movements, bodily expressions, facial expressions, eye gaze, physiological data from users

– Whether robot modules are involved so that they are *hybrids* with respect to virtuality, as with the example of the *iCat*, which is not purely virtual (see fig. 2c).

In spite of these differences, all virtual characters have – albeit to different degrees – the following four properties: *humanlikeness, interactivity*, *virtualness*, and *socio-emotional affordances* (see next section). The combination of these properties makes them different from all other hitherto human-made artefacts and systems. This, in turn, makes them interesting to explore in various ways.

2 Socio-emotional affordances of virtual characters

The fourth characteristic in the list above, socio-emotional affordances, deserves some elaboration since an understanding of this is central when discussing virtual characters and cognitive science research.

When a person interacts with a virtual character (remember we are not considering avatars, with a human behind controlling them) she or he is facing *a computer program*, something realized by electronics, metallics, a screen, etc. There is nothing alive, nothing sentient, nothing social there. In general this is of course firmly known by people interacting with virtual characters. Nevertheless, people in many respects respond *as if* virtual characters were *socio-emotional entities*. Numerous studies have identified similarities in how humans tend to interpret, attribute characteristics to, and respond emotionally to virtual characters and to other humans. For instance, it has been shown that:

– People respected social norms towards virtual characters in VR environments, even though they were well aware that the agents were computer-generated. For instance, they would not “disturb” a character that seemed busy or occupied with something (Garau et al., 2005).

– Experiences and interactions were similar when students performed a training task with a real patient and a virtual patient (Lok et al., 2006).

– People were inclined to interrupt their participation in a study when asked to give virtual electric chocks to a virtual character, which was furthermore not visually realistic (Slater et al., 2006).

– Patterns of social inhibitions in the presence of a real human observer recurred when a virtual agent observer was present (Zanbaka et al., 2007).

– People ascribed significantly higher degrees of warmth and pleasantness, but lower degrees of objectivity and confidence, to a virtual female medical doctor with a more feminine look than to one with a less feminine look (everything apart from their visual appearance being equal) – a recurring pattern from social psychology established with real people (Gulz et al., 2007a).

There is some variety between different groups of people in these response patterns. Already in young children, some individuals take a more detached approach to humanlike (anthropomorphic) artefacts than others and approach them in terms of "how does this thing work?" rather than taking a social approach to them (Turkle et al., 2006). Also in adults we find differences in their inclination to enter an *as if* mode (Lomard & Ditton, 1997).[2] But in spite of this variation, the remarkable thing is that *the overall effects and patterns exist*.

Why do people seem polite, considerate or emphatic towards computer programs? A key notion is *as if*. Nobody (at least not above a certain age) believes that these are social, emotional, or sentient "creatures". But we spontaneously respond and make attributions *as if* they were. A related notion, also used by *Disney*, is *suspension of disbelief*. We do not believe that cartoon characters in films are "real", but we suspend that disbelief and become engaged in them.

In an attempt to look behind the scenery, Reeves and Nass (1996) propose the following explanation: Those patterns of interpretations and responses are hardwired in our brains. During the eras of time when *Homo sapiens* evolved, anything that exhibited social signals (voice, language, eyes, mouth, etc.) *was* de facto a social actor (and as such of importance to us). Our interpretations and responses when we encounter such social signals occur on an automatic cognitive level, not a controlled and reflective one.[3]

With this background it is now time to consider two main motives for cognitive science research on virtual environments and characters. Section 3 presents the more obvious one: to *study and explore* them and human beings' interaction with them. Section 4 discusses the less obvious – but exciting – possibilities to make use of virtual environments and characters as a *research tool* for studying human communication, socio-cognition, and interaction.

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[2] Another observation is that the patterns in social responses sometimes is there but is weaker with virtual environments and characters than with real environments and human beings – which in turn may be related to individual variation being larger in these cases.

[3] There is also neuropsychological evidence indicating that humans are hardwired to respond to cues that suggest that an entity has intentionality, since certain kinds of behaviours activate neuropsychological reponses which seem to lead to the perception that these entities are "living" as opposed to "non-living" (Gainotti et al. 1995).

3 Virtual characters and human beings interacting with them – an object of research

There are a large number of issues that are explored in the field, a small sample of which is presented here.

– To what extent can a virtual environment with virtual instructors or learning companions help students to train/learn things and materials that they otherwise find difficult to handle, for instance due to phobias? (Pertaub et al., 2001)

– To what extent can virtual instructors or coaches function as role models and help increase students' beliefs in their own abilities within a certain domain? (Baylor et al., 2006; Gulz et al., 2007; Kim et al., 2007; Gulz, 2008)

– Can one usefully train interaction and social communication with virtual characters before going to a foreign country? (Johnson, 2003; Babu et al., 2007)

– Can a training program, including a virtual speech assistant, be a relevant complement for individuals who suffer from Aphasia, Parkinson's disease or the like? (Van Vuuren, 2006)

– Can virtual character-based systems be used to affect health-related behaviours (reducing smoking, doing physical exercise, following medication)? (Bickmore, 2003; Bickmore, 2007; Bickmore & Pfeifer, 2008)

– Can virtual environments provide useful training for individuals with a diagnosis within the autism spectrum? (Tartaro & Cassell, 2007)

– Can medical students train patient communication by means of virtual environments and virtual patients? (Lok et al., 2006)

– Can interaction with virtual characters have negative influences on human discourse, and can it also influence our ways of approaching real human beings? (De Angeli et al., 2006; Veletsianos et al., 2008)

The sample issues above should make it obvious that there are both potential benefits and potential risks associated with these novel artefacts. There is much that we do not yet know about their present and potential effects on ourselves as cognitive and socially interacting beings. Research questions driven by a desire to explore and find out, go along with more pragmatic questions regarding how we can make these artefacts productive.

In one of our projects (Gulz et al., 2007b) we investigate how different virtual coaches may affect attitudes towards educational programmes associated with gendered cultural images or prototypes. The preliminary results indicate a potential in the use of more androgynous-looking virtual coaches, and connect to the larger field of studies that explore the potential in virtual worlds to offer a broader range of styles and identities than the real world (e.g. Rommes, 2007).

Another of our projects is directed at a topic that is crucial for many kinds of virtual environment applications, within education, counselling, e-commerce, and so on, namely the topic of confidence and trust. What are the relations between trust in real versus trust in virtual environments? What are the relations between trust in real people versus trust in virtual characters? In a series of studies we use a set-up where certain stimuli are exchanged for others without subjects knowing this (using choice blindness techniques, described in more detail in chapter 16, this volume). In these studies we attempt to study the variables *physically real material*; *virtual material*; *real person* (social reality); and *virtual person* (social virtuality). (See Fig. 3.) By manipulations of parameters known to affect trust in contexts with real people and materials, we hope to shed more light on these issues (Johansson et al., 2007).

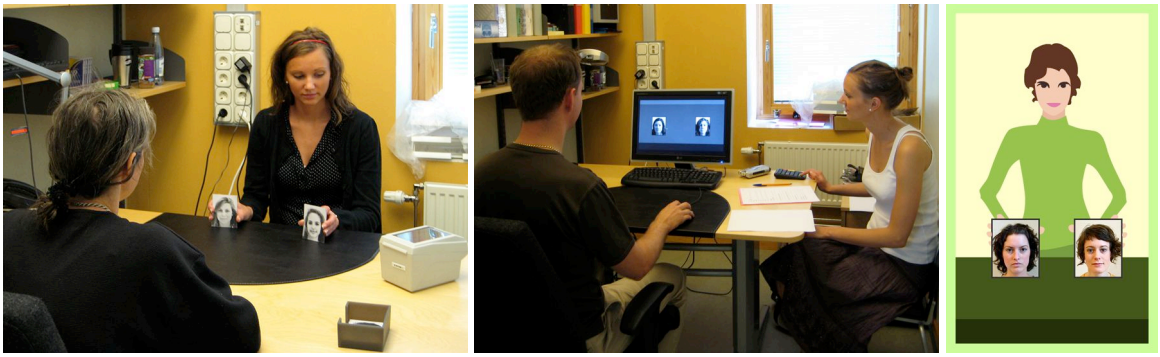


Fig. 3. Three different settings: (a) Physical experimental leader and material; (b) Physical experimental leader and virtual material; (c) Virtual experimental leader and material

In sum, there are several research issues where virtual environments and characters, and people's interacting with them, constitute the *object of study*. The next section considers how virtual characters and environments can also be exploited as *research instruments* in order to develop better theories and models of human beings as socially interacting and communicating creatures.

4 Research tools for finding out more about human beings

4.1 Virtual laboratories

As noted, people do not approach and respond to virtual characters as "simple computer programs". Instead they use similar patterns of attributions, evaluations, and emotional responses as when encountering human beings.

Once such a pattern of attributions, evaluations, or responses has been identified with respect to a given virtual character environment, we have the following situation. It is now possible to *systematically vary* chosen aspects of the virtual characters while keeping the others constant, and thus study how responses are affected when a particular character's aspect is manipulated in various ways. These aspects can be manners of speaking, sociolects, looks, gender, body language, ethnicities, styles of interaction, ways of looking, etc. In the wording of Vinayagamoorthy et al. (2004), "Virtual characters present promising avenues for research into social interaction because they enable the controlled manipulation of specific visual and behavioural variables" (p. 125).

As an example, consider a virtual environment for language training including a virtual learning companion with whom to practice dialogue. Peer-to-peer learning is known to be a powerful way to learn. However, it is not altogether clear what parameters influence the results in terms of learning outcomes when peers learn from one another. How are learning outcomes influenced if peers speak a similar dialect or not? What are the effects of having a peer that gives feedback in one way or in another; of a smiling and joking peer learner versus a more serious and task oriented peer; of various differences in linguistic competence levels? Such questions can be addressed in the kind of setting described, since it provides a virtual laboratory where chosen aspects can be varied and different groups of participants encounter different conditions. (Cf. work of Ryokai et al., 2003; Kim et al., 2007.) Note that it is not possible to conduct similar studies with manipulating real human beings. We cannot tell someone "now do everything as before, just be four years older" or "please change gender" or "please change your linguistic competence". Bickmore et al. (2005) make a similar point when discussing the use of virtual characters to explore communicative effects of particular variables in doctor-patient interaction. Many aspects can be controlled in virtual characters in ways that are impossible with human beings, and for instance "the effects of subtle but precise changes in physician nonverbal behaviour on patient understanding could be assessed, something that would be very difficult to do with human confederates" (p. 4).

Overall, virtual experimental studies may provide clues about human-human (social) interaction on a level of detail that has until now not been possible. It should, furthermore, be pointed out that when using virtual characters as a research instrument one is not restricted to autonomous agents. One can also combine semi-autonomous agents, large amounts of pre-scripted behaviours, and a human being sitting behind (without the user knowing) and putting together the interaction in real time – so called *Wizard-of-Oz* technique (Dahlbäck et al., 1993). Since what there is "behind" in terms of underlying mechanisms is not in focus, any functioning combinations of *Wizard-of-Oz* techniques and agents/characters can be used.

4.2 Evidence through interaction

Since subjects *interact* with virtual environments and characters, a study can provide data concerning things such as *how long* people interact with different characters, *in what way* they approach and communicate with different characters, or how they react in terms of facial expressions or psychophysical responses when interacting with different characters. Such data can provide a more complex picture than interview and questionnaire data alone on how people perceive and think about different characters.

In particular, the combination of behavioural and psychophysical data with interview and questionnaire data opens up exciting possibilities to gain data that refers to different layers in cognitive and affective processing. For instance, articulated and more mindful responses do not always concord with more unconscious and mindless responses. In some of our studies we have seen evidence of this. As an example, subjects denied when asked explicitly about it, that they would find a certain lecture presented by a female character with a more feminine appearance less objective than if the same lecture was presented by a female character with a less feminine appearance. However, more indirect measurements showed this to be the case (Gulz et al., 2007a).

4.3 A modelling and implementation tool

Behind any virtual character there is a more or less complex cognitive model. From this perspective, research and development of virtual characters is part of the broader modelling domain with computational modelling, robotics and hybrid systems (robots +virtual agents).

Generally modelling takes one of two different approaches: (i) to produce something that will make "the surface" work, no matter what mechanisms are used and whether they are similar to mechanisms found or supposed to exist in living systems, or (ii) to implement a theory or mechanism that one believes to exist also in living systems. (If for example, one wants to build an affective agent able to respond to facial expressions of humans, one might build a model of mimicking behaviour.) By thus implementing and running (parts of) the theories, one may test theories about aspects of human cognition and interaction.

For theories of *embodied cognition*, comparative work on virtual agents, robots, and robot-agent-hybrids is especially enticing. Virtual agents do not have bodies in the sense that robots do, but are also not as body-less or disembodied as, say, a command line interface. They have *virtual bodies*, and much concern and attention is paid to these virtual bodies (compare the notion *embodied* agent) which provide possibilities to separate out aspects relating to embodiment, in particular to probe developmental issues. There is a variety of theories about which mechanisms and abilities are built-in in humans in contrast to which develop over time, and more specifically about what role various aspects of bodyness have in this.

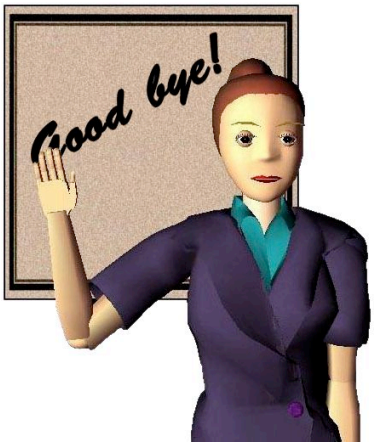
Perhaps virtually embodied cognition can even be framed as an alternative falling between abstract armchair cognitive science and studies of real, situated, and embodied cognition – where the latter is often cumbersome and difficult to conduct due to limited resources and other constraints.

5 Concluding remarks

I have discussed virtual environments and characters and people's interacting with them as an *object of study*. Furthermore, I have discussed virtual environments and characters as *research instruments*. Yet another possible motive for engaging in this field is a desire to bring long-term and human-centred perspectives into the technological and commercial development in the area.

For one thing, many ethical issues are raised (De Angeli et al., 2006; Veletsianos et al., 2008; Haake & Gulz, in press). Academic research on virtual characters can make important contributions here by going along with the technological and commercial development and attempting to evaluate novel systems and artefacts, with respect to human perspectives, *before* they enter the scene on a large scale – that is, conducting *proactive* research in contrast to retrospective analyses on *faits accomplis*. Although ethical perspectives are not always easily applied in straightforwardly commercial domains, there are many domains within health care and medicine, education, and the public sector in general, where it is fully possible to provide guidelines on virtual environments and characters based on academic research.

Powerful potentials for research, powerful potentials for applications and, not least, the possibility to mesh them – these are hallmarks of the field of virtual environments and virtual characters.



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