

Part I

Conversational Artifacts

2

Conversational Agents and the Construction of Humorous Acts

Anton Nijholt

2.1 Introduction

Social and intelligent agents have become a leading paradigm for describing and solving problems in human-like ways. In situations where it is useful to design direct communication between agents and their human partners, the display of social and rational intelligence in an embodied human-like agent allows natural interaction between the human and the agent that represents the system the human is communicating with. “Embodied” means that the agent is visualized on the screen as a 2D or 3D cartoon character that shows human behavior through its animations. Research in intelligent agents includes reasoning about beliefs, desires, and intentions. Apart from contextual constraints that guide the agent’s reasoning and behavior, other behavioral constraints follow from models that describe emotions. An overview of emotion theories and an implementation in the context of an embodied conversational agent can be found in Chapter 3 of this book. These models often assume that emotions emerge based on appraisals of events taking place in the environment and based on how these events affect the goals that are being pursued by the agents. In current research, it is also not unusual to incorporate personality models in agents to adapt this appraisal process as well as reasoning, behavior, and display of emotions to personality characteristics. So, we can model lots of useful and human-like properties in artificial agents, but, in Roddy Cowie’s (2000) words, “If they are going to show emotion, we surely hope that they would show a little humor too.” This chapter anticipates the need for such agents by exploring the relevant research questions.

Embodied conversational agents (ECAs) have been introduced to play, among others, the role of conversational partner for the computer user. Rather than addressing the “machine”, the user addresses virtual agents that have particular capabilities and can be made responsible for certain tasks. The user may interact with ECAs to engage in an information service dialogue, a transaction dialogue, to solve a problem cooperatively, perform a task, or to engage in a virtual meeting. Other obvious applications can be found in the areas of education (including training and simulation), entertainment, electronic commerce, and teleconferencing. Research projects suggest that in the near future we might expect that, in addition to being domain and environment experts, ECAs will act as personal assistants, coaches, and buddies.

They will accompany their human partners, migrating from displays on handheld devices to displays embedded in ambient-intelligence environments. Natural interaction with these ECAs will require them to display rational and social intelligence and, indeed, also a little humor when appropriate and enjoyable. In this interaction with embodied conversational agents, verbal and nonverbal communication is equally important. Multimodal emotion display and detection are among the research issues in this area of human-computer interaction. And so can be investigations in the role of humor in human-computer interaction.

In previous years researchers have discussed the potential role of humor in the interface. However, when we compare efforts in this area with efforts and experiments that demonstrate the positive role of general emotion modeling in the user interface, then we must conclude that attention is still minimal. As we all know, a computer can be a source of frustration rather than enjoyment. A lot of research is focused on detecting a user's frustration (Klein *et al.* 2002; Picard and Klein 2002) – for example in educational settings – and not on generating enjoyment. Useful observations about the positive role of humor in the interface were made by Binsted (1995) and Stock (1996). Humans use humor to ease communication problems in human-human interaction and in a similar way humor can be used to solve communication problems that arise with human-computer interaction. Binsted emphasizes the role of humor in natural language interfaces. Humor can help to make the imperfections of natural language interfaces more acceptable for the users, and when humor is sparingly and carefully used it can make natural language interfaces much friendlier.

In earlier years the potential role of embodied conversational agents was not at all clear and no attention was paid to their possible role in the interface. In Nijholt (2002) we first discussed the role of humor for embodied conversational agents in the interface. It is a discussion on the possible role of humor support in the context of the design and implementation of embodied conversational agents. This role can be said to follow from the so-called CASA (Computers Are Social Actors) paradigm (Reeves and Nass 1996), assuming that humans contribute human-like properties to embodied agents that can help in obtaining more enjoyable interactions, similar, as such properties, when assigned to a human partner help to make the conversation more enjoyable. More recently, several observations about computational humor appeared in Binsted *et al.* (2006).

In the next section we have a short literature survey of the role of humor in human-human interaction. In section 2.3 we discuss embodied conversational agents and their use in intelligent and social user interfaces. We also make clear why the role of humor in human-human interaction can be translated to a similar role in human-computer interaction, in particular when the interface is inhabited by one or more embodied conversational agents. In section 2.4 we have observations on how to decide to generate a humorous act and on the appropriateness of displaying it. In section 2.5 we look at the incongruity theory in humor research and we consider erroneous ambiguity resolution, in particular erroneous anaphora resolution, as a strategy to generate humorous acts. Some notes on an implementation of the ideas are also provided. An example of humorous act generation is presented. Section 2.6 discusses nonverbal support for humor generation. Possible tools and resources that are needed in future research are discussed in section 2.7. Finally, section 2.8 contains the conclusions of this chapter.

2.2 The Role of Humor in Interpersonal Interaction

In interpersonal interactions humans use humor, humans smile and humans laugh. Humor can be spontaneous, but it can also serve a social role and be used deliberately. A smile can be the effect of appreciating a humorous event, but it can also be used to regulate the conversation. A laugh can be spontaneous but can also mask disagreement or be cynical. Research has shown that laughs are related to topic shifts in a conversation and phases in negotiations or problem solving tasks. In an educational situation humor can be used by the teacher to catch students' attention but also to foster critical thinking. Humor allows criticism to be smoothed, stress can be relieved and students can become more involved in joint classroom

activities by the use of humor (Ziv 1988). Humor can also help when it comes to frustration. In an (e-)commerce situation negotiators use humor to induce trust.

Here we discuss the role of humor in human–human interaction. Results from experimental research are surveyed. First we are concerned with general issues, not necessarily connected to a particular domain, but playing a role in human–human interaction in general: humor support in a conversation, interpersonal attraction, and trust. More topics could have been chosen, but the mentioned issues arise naturally when later in this section domains are discussed where in the near future embodied conversational agents will play the roles of one or more of the conversational partners in the current real-life situations. The domains that are chosen are education, information services and commerce, meetings, and negotiations.

2.2.1 General Issues: Support, Attraction, and Trust

It is possible to look at preconceived aims of conversational partners to create humor during a conversation or discussion. However, this chapter rather looks at situations where humor occurs spontaneously during an interaction or where it occurs in a supporting role, for example to hide embarrassment, to dominate the discussion or to change the topic. Some of these roles will get more attention in the next section. The emphasis here is on the role of humor to induce trust and interpersonal attraction and on the appreciation of humor during a conversation.

Humans employ a wide range of humor in conversations. Humor support, or the reaction to humor, is an important aspect of personal interaction and the given support shows the understanding and appreciation of humor. In Hay (2001) it is pointed out that there are many different support strategies. Which strategy can be used in a certain situation is mainly determined by the context of the humorous event. The strategy can include smiles and laughter, the contribution of more humor, echoing the humor, offering sympathy, or contradicting self-deprecating humor. There are also situations in which no support is necessary. In order to give full humor support, humor has to be recognized, understood and appreciated. These factors determine our level of agreement on a humorous event and how we want to support the humor.

Humor support may show our involvement in a discussion, our motivation to continue and how much we enjoy the conversation or interaction. Similarity in appreciation also supports interpersonal attraction, as investigated by Cann *et al.* (1997). This observation is of interest when later we discuss the use of embodied conversational agents in user interfaces. Sense of humor is generally considered a highly valued characteristic of self and others. Nearly everybody claims to have an average to above-average sense of humor. Perceived similarity in humor appreciation can therefore be an important dimension when designing for interpersonal attraction. In Cann's experiments participants had to interact with an unseen stranger. Before the interaction, ratings were made of the attitudes of the participants and they were led to believe that the stranger had similar or dissimilar attitudes. The stranger responded either positively or neutrally to a participant's attempt to humor. The results tell us that similarity in humor appreciation is able to negate the negative effects of dissimilarity for other attitudes when looking at interpersonal attraction. Other studies show how similarity in attitudes is related to the development of a friendship relationship. The development of a friendship relationship requires time, but especially in the initiation phase the kinds of similarities mentioned above can be exploited.

Friendship and intimacy are also closely related. Trust is an essential aspect of intimacy and the hypothesis that there also exists a correlation between humor and trust has been confirmed (Hampes 1999). There are three key factors that help us to understand this relationship. The most important factor is the demonstrated relation between humor and extroversion (Ruch 1994). When we break up extroversion into basic components like warmth, gregariousness, assertiveness, and positive emotions it becomes obvious that extroversion involves trust. Another factor, mentioned above, is the fact that humor is closely related to a high self-esteem. People who are proud of who they are are more likely to trust other persons and to reveal themselves to them. A third factor is that humorous persons are effective in

dealing with stress (Fry 1995). They are well qualified to deal with the stress or anxieties involved in interpersonal relationships and therefore more willing to enter relationships.

2.2.2 *Conversations and Goal-directed Dialogues*

Humor plays a role in daily conversations. People smile and laugh, certainly not necessarily because someone pursues the goal of being funny or tells a joke, but because the conversational partners recognize the possibility to make a funny remark fully deliberately, fully spontaneously, or something in between, taking into account social (display) rules. We will not go deeply into the role of humor in daily conversations, small talk or in entertainment situations. In daily conversations humor very often plays a social role, not only in conversations with friends and relatives (Norrick 1993), but also in the interaction with a real estate agent, a saleswoman, a tourist guide, a receptionist or a bartender. It is difficult to design experiments intended to find the role played by humor in human-to-human interactions, when no specific goals are defined. Even experiments related to rather straightforward business-to-consumer relationships are difficult to find. Rather we have to deal in these situations with regulations protecting a customer from humor by a salesman (never use sarcasm, don't make jokes at the expense of the customer, etc.).

When looking at the more goal-directed situations, teaching seems to be one field where the use of humor has received reasonable attention. Many benefits have been mentioned regarding humor in the teaching or learning process and sometimes made explicit in experiments. Humor contributes to motivation attention, promotion of comprehension and retention of information, a more pleasurable learning experience, a development of affective feelings toward content, fostering of creative thinking, reducing anxiety, etc. The role of humor during instruction, its social and affective functions for teaching, and the implications for classroom practice has been discussed in several papers. However, despite the many experiments, it seems to be hard to generalize from the experiments that are conducted (Ziv 1988).

The role of humor and laughter during negotiation processes is another issue that has received attention. In Adelswärd and Öberg (1998) several tape recordings made during international negotiations have been analyzed. One of the research questions concerned the interactional position of laughter: When do we laugh during interaction? Different phases during negotiation can be distinguished. Laughing events turned out to be related to the phase boundaries and also to discourse boundaries (topic shifts). Hence, laughter serves interactional goals. The distinction between unilateral and joint laughter is also important. Mutual laughter often reflects consensus, unilateral laughter often serves the same function as intonation.

Describing and explaining humor in small task-oriented meetings is the topic of a study conducted by Consalvo (1989). An interesting and unforeseen finding was the patterned occurrence of laughter associated with the different phases of the meeting. The opening phase is characterized by its stiffness and serious tone and the atmosphere of distrust. Humor in this phase is infrequent. This contrasts with the second, transitional phase that lasts only a couple of minutes and the humorous interactions are frequent and for the first time during the meeting all participants laugh. Their laughter conveys the agreement that the problem can be solved and the commitment of the individual participants. The last phase, the problem-solving phase, contains a lot more humorous events than the opening phase, but still less than the transitional phase. In this way humor echoes the progression of a meeting.

2.3 Embodied Conversation Agents

2.3.1 *Introduction*

Embodied conversational agents (ECAs) have become a well-established research area. Embodied agents are agents that are visible in the interface as animated cartoon characters or animated objects resembling human beings. Sometimes they just consist of an animated talking face, displaying facial expressions and, when using speech synthesis, having lip synchronization. These agents are used to inform and explain



Figure 2.1 Doctor in a simulation environment

or even to demonstrate products or sequences of activities in educational, e-commerce or entertainment settings. Experiments have shown that ECAs can increase the motivation of a student or a user interacting with the system. Lester *et al.* (1997) showed that a display of involvement by an ECA motivates a student in doing (and continuing) his or her learning task. In the following figures we show two examples of ECAs. The virtual human displayed in Figure 2.1 represents a doctor that plays a role in a simulation environment where a US soldier in Iraq has to persuade the doctor to move his medical clinic to a safer area. Such simulation environments are researched at the Institute for Creative Technologies in Marina del Rey.

The second example (Figure 2.2) is the GRETA agent developed by Catherine Pélachaud (Hartmann *et al.* 2005). This ECA has been made available for many applications. In this particular situation it is used

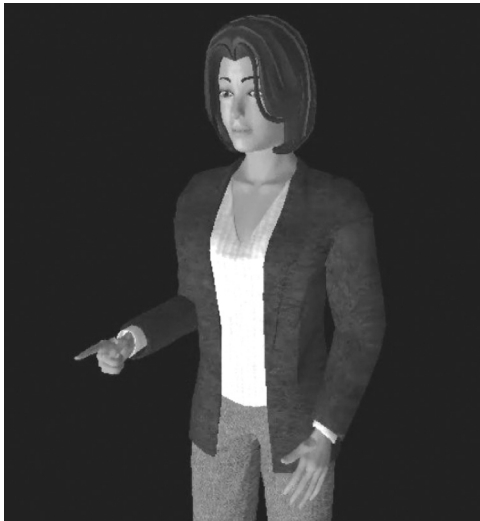


Figure 2.2 GRETA agent

to experiment with different expressivity settings for communication, that is, expressivity in gestures and body postures depending on emotion, personality, culture, role, and gender.

2.3.2 *Nonverbal and Affective Interaction for Embodied Agents*

An embodied agent has a face. It may have a body, arms, hands, and legs. We can give it rudimentary intelligence and capabilities that allow smooth and natural verbal and nonverbal interaction. Nonverbal signals come from facial expressions, gaze behavior, eyebrow movements, gestures, body posture, and head and body movements. But they are also available in the voice of an ECA. Communicative behavior can be made dependent on the personality that has been modeled in an ECA.

In previous years we have seen the emergence of affective computing. Although many research results on affect are available, it is certainly not the case that a comprehensive theory of affect modeling is available. Reasons to include emotion modeling in intelligent systems are, among others, to enable decision-making in situations where it is difficult, if not impossible, to make rational decisions, to afford recognition of a user's emotions in order to give better and more natural feedback, and to provide display of emotions, again, in order to allow natural interaction. Especially when the interface includes an ECA, it seems rather obvious that the user expects a display of emotions and some recognition of emotions by the embodied agent. On the other hand, in order to improve the interaction performance of embodied agents they should integrate and use multimodal affect information obtained from their human conversational partner. Measurement techniques and technology are becoming available to detect multimodal displayed emotions in human interactants (e.g., cameras, microphones, eye and head trackers, expression glasses, face sensors, movement sensors, pressure sensitive devices, haptic devices, and physiological sensors). In order to recognize and interpret the display of humor emotions by human interactants (and to be perceived by an ECA) we need to look at, among others, computer vision technology and algorithms for the interpretation of perceived body poses, gestures, and facial expressions.

Speech and facial expressions are the primary sources for obtaining information of the affective state of an interactant. Therefore an ECA needs to be able to display emotions through facial expressions and the voice. In speech, emotion changes can be detected by looking at deviations from personal, habitual vocal settings of a speaker because of emotional arousal. Cues come from loudness, pitch, vibrato, precision of articulation, etc. Kappas *et al.* (1991).

To describe emotions and their visible facial actions, facial (movement) coding systems have been introduced (Ekman 1993). In these systems facial units have been selected to make up configurations of muscle groups associated with particular emotions. The timing of facial actions is also described. Using these systems, the relation between emotions and facial movements can be studied and it can be described how emotion representations can be mapped on the contraction levels of muscle configurations. Modalities in the face that show affect also include movements of lips, eyebrows, color changes in the face, eye movement and blinking rate. Cues combine into expressions of anger, into smiles, grimaces or frowns, into yawns, jaw-droop, etc. Happiness, for example, may show in increasing blinking rate. Generally, we need the ability to display intensities and blends of emotions in the face.

2.3.3 *Computers and Embodied Conversational Agents as Social Actors*

Embodied agents are meant to act as conversational partners for computer users. An obvious question is whether they, despite available verbal and nonverbal communication capabilities, will be accepted as conversational partners.

Can we replace one of the humans in a human-to-human interaction by an embodied conversational agent without being able to observe important changes in the interaction behavior of the remaining human? Can we model human communication characteristics in an embodied conversational agent that

guarantee or improve natural interaction between artificial agent and human partner? Obviously, whether something is an improvement or more natural depends very much on the context of the interaction, but being able to model such characteristics allows a designer of an interface employing embodied agents to make decisions about desired interactions.

In the research on the “computers are social actors” (CASA) paradigm (Reeves and Nass 1996) it has been convincingly demonstrated that people interact with computers as if they were social actors. Due to the way we can let a computer interact, people may find the computer polite, dominant, extrovert, introvert, or whatever attitudes or personality (traits) we can think of. Moreover, they react to these attitudes and traits as if a human being displayed them. As an example, consider the situation where a person interacts with the computer in order to perform a certain task. When, after completing the task, the person is asked by the same computer about its (i.e., the computer’s) behavior, the user is much more positive than when asked this question while sitting behind another computer.

From the many CASA experiments we may extrapolate that humor, because of its role in human–human interaction, can play an important role in human–computer interactions. This has been confirmed with some specially designed experiments to examine the effects of humor in task-oriented computer-mediated communication and in human–computer interaction (Morkes *et al.* 2000). It was shown that humor could have many positive effects. For example, participants who received jokes during the interaction rated a system as more likable and competent. They smiled and laughed more, they responded in a more sociable manner and reported greater cooperation. This showed especially in the computer-mediated communication situations. Moreover, in their experiments the use of humor in the interface did not distract users from their tasks. According to the authors the study provided strong evidence that humor should be incorporated in computer-mediated communication and human–computer interaction systems.

In the CASA experiments, the cues that were used to elicit the anthropomorphic responses were minimal. Word choice, for instance, elicited personality attribution, voice pitch elicited gender attribution. In ECAs, however, the cues are not even minimal. Gender can be communicated by means of physical appearance and voice, personality can be communicated by means of behavior, word choice and nonverbal communication, much like is the case in human–human interaction. Consequently, the CASA paradigm should be applicable to ECAs at least as well as to computers in general.

In Friedman (1997) research is reported where in the interaction with users the computer is represented as an embodied agent. Again, the starting point is how human facial appearance influences behavior and expectations in face-to-face conversations. For example, a happy, friendly face predicts an enjoyable interaction. In experiments people were asked to talk to different synthetic faces and comparisons were made with a situation where the information was presented by text. General observations were that people behave more socially when communicating with a talking face, they are more attentive, they present themselves in a more positive light, and they attribute personality characteristics to the talking face. It was shown that different faces and facial expressions have impact on the way the user conceives the computer and also on the interaction behavior of the user.

The results of the CASA experiments indicate that users respond to computers as if they were humans. Of course, this doesn’t mean that people will interact with computers exactly as they do with humans. Shechtman and Horowitz (2003) conducted experiments to study relationship behavior during keyboard human–computer interaction and (apparently) keyboard mediated human–human interaction. In the latter case participants used much more communion and agency relationship statements, used more words, and spent more time in conversation. Nevertheless, we conclude that it is possible, at least in principle, to design systems and more in particular embodied agents that are perceived as social actors and that can display characteristics that elicit positive feelings about an interaction, even though the interaction is not considered as perfect from the user’s point of view. In the next section we study in more detail the possibility of generating humorous acts in order to introduce humor characteristics known to improve interaction in human–human interaction into human–computer interaction.

2.4 Appropriateness of Humorous Acts in Conversations

2.4.1 Introduction

In the previous sections we discussed the role of humor in human–human interaction and a possible role of humor in human–ECA interaction. Obviously, there are many types of humor and it is certainly not the case that every type of humor is suited for any occasion during any type of interaction. Telling a joke among friends may lead to amusement, while the same joke among strangers will yield misunderstanding or be considered as abuse. Therefore, an assessment of the appropriateness of the situation for telling a joke or making a humorous remark is always necessary.

Appropriateness does not mean that every conversational participant has to be in a jokey mood for a humorous remark. Rather, it means that the remark or joke can play a role in the interaction process, whether it is deliberately aimed at achieving this goal, whether there is a mutually agreed moment for relaxing and playing, or whether it is somewhere in between on this continuum. Clearly, it is also the “quality” of the humorous remark that makes it appropriate in a particular situation. Here, “quality” does not refer only to the contents of the remark, which may be based on a clever observation or ingenious wordplay, but in particular on an assessment whether or not to produce the remark at that particular moment.

In what follows we will talk about “humorous acts” (HAs). In telephone conversations a HA is a speech utterance. Apart from the content of what is being said, the speaker can only use intonation and timing in order to generate or support the humorous act. Obviously, we can think of exceptions, where all kinds of non-speech or paralinguistic sounds help to generate – on purpose or by accident – a HA. In face-to-face conversations a humorous act can include, be supported by or even made possible by nonverbal cues. Moreover, references can be made, implicitly or explicitly, to the environment that is perceivable for the partners in the conversation. This situation also occurs when conversational partners know where each of them is looking at or when they are able to look at the same display, display contents (e.g., a web page) or a shared virtual reality environment.

Although mentioned before, we emphasize that participants in a discussion may, more or less deliberately, use humor as a tool to reach certain goals. A goal may be to smooth the interaction and improve mutual understanding. In that case a HA can generate and can be aimed at generating feelings of common attitudes and empathy, creating a bond between speaker and hearer. However, a HA can also be face threatening and be aimed at eliminating an opponent in a (multi-party) discussion. However, whatever the aim is, conversational participants need to be able to compose elements of the context in order to generate a HA and they need to assess the current context (including their aims) in order to determine the appropriateness of generating a HA. This includes a situation where the assumed quality of the HA overrules all conventions concerning cooperation during a goal-oriented dialogue.

Sometimes, conversations have no particular aim, except the aim of providing enjoyment to the participants. The aim of the conversation is to have an enjoyable conversation and humor acts as a social facilitator. In Tannen (1984), for example, an analysis is given of the humorous occurrences in the conversations held at a Thanksgiving dinner. Different styles of humor for each of the dinner guests could be distinguished. All guests had humorous contributions. For some participants more than ten percent of their turns were ironic or humorous. With humor one can make one’s presence felt, was one of her conclusions.

Generation (and interpretation) of HAs during a dialogue or conversation has hardly been studied. There is not really a definition, but at least the notion of conversational humor has been introduced in the scientific literature (Attardo 1996), emphasizing characteristics as being improvised and being highly contextual. Conversational humor is in kidding and in teasing and, by acting the improvisation, it is the main ingredient of sitcoms (situation comedies). Many observations on joke telling during conversations are valid as well for HA generation during a conversation. Before going into some more details of generating HAs we repeat some of them here.

Raskin (1985) discussed speaker–hearer couplings for joke telling obtained from the four situations arising from a speaker who intentionally or unintentionally makes a joke and a hearer who expects or does not expect it. Although we won't exclude the situations where a speaker unintentionally performs a HA or where the hearer expects a HA to be generated, we will mostly assume the situation where the speaker intentionally constructs a HA and the hearer is assumed not to expect it.

The next (related) observation concerns the Gricean cooperation principle. Grice's assumption was that conversational partners are cooperative. Jokes are about misleading a conversational partner. However, explicit joke telling is often preceded by some interaction that is meant to obtain agreement about the inclusion of a joke in the interaction. In such a case there is explicit announcement and agreement to make a switch from a bona-fide mode of communication to a non-bona-fide mode of communication. Contrary to a situation where someone starts telling lies, within the constraints of humor the communication can nevertheless be bona-fide since speaker and hearer agree about the switch. When the participants are in the mood for jokes, joke telling occurs naturally and there is some meta-level cooperation. Raskin (1985), Zajdman (1991) and Attardo (1997) all discuss variants and extensions of the Gricean cooperation principle, allowing such “non-cooperative” or non-bona-fide modes of behavior.

Related to this discussion and also useful from the point of view of HA generation and appreciation is the introduction of the double-bond model in Zajdman (1992). In this model the primary bond between speaker and hearer consists of both making the switch from the usual bona-fide mode of communication to the humorous (non-bona-fide) communication mode. It is not necessarily the case that the speaker makes this switch before the hearer does. An unintentional humorous remark may be recognized first by the hearer or it can even be elicited by the hearer in order to create a funny situation. In our HA generation view we assume, however, that the speaker intentionally makes this switch and the hearer is willing to follow. The secondary bond concerns the affirmation of the switch for both parties. When consent is asked and obtained to tell a joke during a conversation, the secondary bond is forged before the primary bond. But it can also occur during or after communicating a humorous message. Some synchronization should be there since otherwise the humorous act will not be successful. Obviously, in face-to-face conversations nonverbal cues can make verbal announcements and confirmations superfluous. And, as mentioned before, when the conversational partners are in the mood for jokes, there is some meta-level cooperation bypassing the requirements for making and acknowledging mode switches.

We emphasize the spontaneous character of HA construction during conversational humor. The opportunity is there and, although the generation is intended, it is also unpredictable and irreproducible. Nevertheless, it can be aimed at entertaining, to show skill in HA construction or to obtain a cooperative atmosphere. HA creation can occur when the opportunity to create a HA and a humorous urge to display the result temporarily overrules Gricean principles concerning truth of the contribution, completeness of the contribution, or relevance of the contribution for the current conversation.

The moment to introduce a canned joke during a conversation can also be related to the situation. It can be triggered by an event (a misunderstanding, the non-availability of information, word choice of a conversational partner, etc.), including a situation where one of the conversational partners does not know what to contribute next to the conversation. However, the contribution – and not the moment – remains canned, although the joke can become merged with the text and adapted to fit a contextual frame (Zajdman 1991). In contrast, conversational HAs are improvised and more woven into the discourse through natural contextual ties. There is no or hardly any signaling of the humorous nature of the act and, in fact, this would reduce or destroy its effect.

2.4.2 Setting the Stage for Humor Generation by Embodied Conversational Agents

When leaving the face-to-face conversations in human–human interaction and entering a situation where one of the humans is replaced by a computer, or more in particular, an embodied conversational agent,

we have to reconsider the roles of the conversational partners. To put it simply, one of the partners has to be designed and implemented. While on the one hand we nevertheless need to understand as well as possible the models underlying human communication behavior, it also gives us the freedom to make our own decisions concerning communication behavior of the ECA, taking into account the particular role it is expected to play. We need to be more explicit about what an ECA's human conversational partner can expect from an ECA. From a design point of view, everything is allowed to make an ECA believable for its human partner. Artists have explored the creation of engaging characters, using advanced graphics and animations, in games and movies with tremendous commercial success. They create believable characters, but there is no modeling of (semi-) autonomous behavior of these characters in a context that allows interaction with human partners. Rather than showing intelligence, "appropriately timed and clearly expressed emotion is a central requirement for believable characters" (Bates 1994). In ECA design, rather than adhere to a guideline that says "try to be as realistic as possible", the more important guideline is "try to create an agent that permits the audience's suspension of disbelief".

When looking at embodied conversational agents we need to distinguish four modes of humor interpretation and generation. We mention these modes, but it should be understood that we are far from being able to provide the necessary appropriate models that allow them to display these skills. On the other hand, we don't always need agents that are perfect, as long as they are believable in their application. The first two modes concern the skills of the ECA:

- The ECA should be able to generate HAs. How should it construct and display the HA? When is it appropriate to do so? Apart from the verbal utterance to be used, it should consider intonation, body posture, facial expression, and gaze, all in accordance with the HA. The ECA should have a notion of the effect and the quality of the HA in order to have it accompanied with nonverbal cues. Moreover, when in a subsequent utterance its human partner makes a reference to the HA, it should be able to interpret this reference in order to continue the conversation.
- The ECA should be able to recognize and understand the HAs generated by its human conversational partner. Apart from understanding from a linguistic or artificial intelligence point of view, this also requires showing recognition (e.g., for acknowledgment) and comprehension by generating appropriate feedback, including nonverbal behavior (facial expression, gaze, gestures, and body posture).

These are the two ECA points of view. Symmetrically, we have two modes concerning the skills of the human conversational partner. Generally, we may assume that humans have at least the skills mentioned above for ECAs.

- The human conversational partner should be able to generate HAs and accompanying signals for the ECA. Obviously, the human partner may adapt to the skills and personality of the particular ECA, as will be done when having a conversation with another human.
- The human conversational partner should recognize, acknowledge and understand HA generation by the ECA, including accompanying nonverbal signals. Obviously, the ECA may have different ideas about acts being humorous than its particular conversational partner.

Our aim is to make ECAs more social by investigating the possibility for them to generate humorous acts. This task can certainly not be done completely isolated from the other issues alluded to: the appreciation of the HA by a conversational partner, the continuation of dialogue or conversation, the double-bond issues, and so on. Two observations are in order. Firstly, when we talk about the generation of a HA and corresponding nonverbal communication behavior of an ECA we should take into account an assessment of the appropriateness of generating this particular HA. This includes an assessment of the appreciation of the HA by the human conversational partner, and therefore it includes some modeling of the interpretation of HAs by human conversational partners. That is, a model for generation of HAs requires a model of interpretation and appreciation of HAs. This is not really different from discourse

modeling in general. An ECA needs to make predictions of what is going to happen next. Predictions help to interpret a next dialogue act or, more generally, a successor of a humorous act.

A second observation also deals with what is happening after introducing a HA in a conversation. What is its impact on the conversation and the next dialogue acts from a humor point of view? This introduces the issue of humor support; that is, apart from acknowledging, will the conversational partner support and further contribute to the humorous communication mood? Hay (2001) distinguishes several types of humor support strategies: contributing more humor, playing along, using echo, and offering sympathy. Support can also mean the co-construction of a sequence of remarks leading to a hilarious or funny observation starting from a regular discourse situation. Trying to model this requires research on (sequences of) dialogue acts, an issue that is rather distant from current dialogue act research, both from the point of view of non-regular sequences of acts and from the point of view of distinguishing sufficiently many subtleties in dialogue acts that initiate and allow such sequences.

Finally, as a third observation, we need to consider whether HA generation by a computer or by an ECA gives rise to HAs that are essentially different and maybe more easily generated or accepted than human-generated HAs. An ECA may have less background and be less erudite, but it may have encyclopedic knowledge of computers or a particular application. In addition, a computer or an ECA can become easily the focus of humor of a human conversational partner. Being attacked because of imperfect behavior can be anticipated and the use of self-deprecating humor can be elaborated in the design of an ECA. In that case the ECA makes itself the butt of humor, for example, by making references to its poor understanding of a situation, its cartoon-like appearance and facial expressions, or its poor quality of speech recognition and speech synthesis.

All these issues are important, but can only be mentioned here. A start has to be made somewhere and therefore we will mainly discuss an ECA's ability to generate an HA without looking too much at what will happen afterwards. Corresponding nonverbal behavior should be added to the generation of a HA, or better, should be designed in close interaction with the generation of verbal acts (Theune *et al.* 2005). We will return to this in section 2.6.

2.4.3 *Appropriateness of Humorous Act Generation*

Humor is about breaking rules, such as violating politeness conventions or, more generally, violating Gricean rules of cooperation (see also section 2.4.1). In creating humorous utterances during an interaction people hint, presuppose, understate, overstate, use irony, tautology, ambiguity, etc. (Brown and Levinson 1978); i.e., all kinds of matters that do not follow the cooperative principles as they were formulated in some maxims (e.g., "Avoid ambiguity", "Do no say what you believe to be false", etc.) by the philosopher Grice (1989). Nevertheless, humorous utterances can be constructive – that is, support the dialogue – and there can be a mutual understanding and cooperation during the construction of a HA. The HAs we consider here are, contrary to canned jokes that often lack contextual ties, woven into the discourse. Canned jokes are not completely excluded, since some of them can be adapted to the context, for example by inserting the name of a conversational partner or by mapping words or events of the interaction that takes place on template jokes (Loehr 1996). Nevertheless, depending on contextual clues a decision has to be made to evoke and adapt the joke in order to integrate it in a natural way in the discourse. Such decisions have also to be made when we consider hints, understatements, ambiguities, and other communication acts and properties that aim or can be used to construct a HA.

For HA construction, we need to zoom in on two aspects of constructing humorous remarks:

- recognition of the appropriateness of generating a humorous utterance by having an appraisal of the events that took place in the context of the interaction; dialogue history, goals of the dialogue partners (including the dialogue system), the task domain and particular characteristics of the dialogue partners have to be taken into account; and

- using contextual information, in particular words, concepts and phrases from the dialogue and domain knowledge that is available in networks and databases, to generate an appropriate humorous utterance, i.e., a remark that fits in the context, that is considered to be funny, is able to evoke a smile or a laugh, or that maybe is a starting point to construct a funny sequence of remarks in the dialogue.

It is certainly not the case that we can look at both aspects independently. With some exceptions, we may assume that, as should be clear from human–human interaction, HAs can play a useful and entertaining role at almost every moment during a dialogue or conversation. Obviously, some common ground, some sharing of goals or experiences during the first part of the interaction is useful, but it is also the quality of the generated HA that determines whether the situation is appropriate to generate this act. We cannot simply assess the situation and decide that now is the time for a humorous act. When we talk about the possibility to generate a HA and assume a positive evaluation of the quality of the HA given the context and the state of the dialogue context, then we are also talking about appropriateness.

In order to generate humor in dialogue and conversational interaction we need to continuously integrate and evaluate the elements that make up the interaction (in its context and given the goals and knowledge of the dialogue system and the human conversational partner) in order to decide:

- the appropriateness or non-appropriateness of generating a humorous utterance, and
- the possibility that elements from the dialogue history, the predicted continuation of the dialogue and knowledge available from domain, task and goals of the dialogue partners allow the construction and the generation of a humorous act.

2.5 Humorous Acts and Computational Humor

2.5.1 Computational Humor

Well-known philosophers and psychologists have contributed their viewpoints to the theory of humor. Sigmund Freud saw humor as a release of tension and psychic energy, while Thomas Hobbes saw it as a means to emphasize superiority in human competition. In the writings of Immanuel Kant, Arthur Schopenhauer, and Henri Bergson, we can see the first attempts to characterize humor as dealing with incongruity, that is, recognizing and resolving incongruity. Researchers including Arthur Koestler, Marvin Minsky, and Alan Paulos have tried to clarify these notions, and others have tried to formally describe them.

As might be expected, researchers have taken only modest steps toward a formal theory of humor understanding. General humor understanding and the closely related area of natural-language understanding require an understanding of rational and social intelligence, so we won't be able to solve these problems until we've solved all AI problems. It might nevertheless be beneficial to look at the development of humor theory and possible applications that don't require a general theory of humor; this might be the only way to bring the field forward. That is, we expect progress in application areas – particularly in games and other forms of entertainment that require natural interaction between agents and their human partners, rather than from investigations by a few researchers into full-fledged theories of computational humor.

Incongruity-resolution theory provides some guidelines for computational humor applications. We won't look at the many variants that have been introduced or at details of one particular approach. Generally, we follow Graeme Ritchie's approach (1999). However, since we prefer to look at humorous remarks that are part of the natural interaction between an ECA and its human conversational partner, our starting point isn't joke telling or pun making, as is the case in the work by Ritchie. Rather, we assume a not too large piece of discourse (a text, a paragraph, or a sentence) consisting of two parts. First you read or hear and interpret the first part, but as you read or hear the second part, it turns out

that a misunderstanding has occurred that requires a new, probably less obvious interpretation of the previous text. So, we have an obvious interpretation, a conflict, and a second, compatible interpretation that resolves the conflict. Although misunderstandings can be humorous, this is not necessarily the case. Deliberate misunderstanding sometimes occurs to create a humorous remark, and it is also possible to construct a piece of discourse so that it deliberately leads to a humorous misunderstanding.

In both cases, we need additional criteria to decide whether the misunderstanding is humorous. Criteria that have been mentioned by humor researchers deal with a marked contrast between the obvious interpretation and the forced reinterpretation, and with the reinterpretation's common-sense inappropriateness. As an example, consider the following dialogue in a clothing store:

LADY: "May I try on that dress in the window?"

CLERK: [doubtfully] "Don't you think it would be better to use the dressing room?"

The first utterance has an obvious interpretation. The clerk's remark is confusing at first, but looking again at the lady's utterance makes it clear that a second interpretation (requiring a different prepositional attachment) is possible. This interpretation is certainly different, and, most of all, it describes a situation that is considered as inappropriate.

What can we formalize here, and what formalisms are already available? Artificial intelligence researchers have introduced scripts and frames to represent meanings of text fragments. In early humor theory, these knowledge representation formalisms were used to intuitively discuss an obvious and a less obvious (or hidden) meaning of a text. A misunderstanding allows at least two frame or script descriptions of the same piece of text; the two scripts involve overlap. To make it clear that the non-obvious interpretation is humorous, at least some contrast or opposition between the two interpretations should exist. Script overlap and script opposition are reasonably well-understood issues, but until now, although often described more generally, the attempts to formalize this opposition mainly look at word-level oppositions (e.g., antonyms such as hot versus cold). Inappropriateness hasn't been formalized at all.

2.5.2 *Generation of Humorous Acts: Anaphora Resolution*

It is possible to look at some relatively simple situations that allow us to make humorous remarks. These situations fit in the explanations we gave earlier and they make it possible to zoom in on the main problems of humor understanding: rules to resolve incongruity and criteria that help determine whether a solution is humorous. Below we present an example of constructing a humorous act using linguistic and domain knowledge. The example is meant to be representative for our approach, not for its particular characteristics. It is an example of deliberately misunderstanding, an act that can often be employed in a conversation when some ambiguity in words, phrases or events is present, in order to generate a HA. It can also be considered as a surprise disambiguation.

We can have ambiguities at pragmatic, semantic, and syntactic levels of discourse (text, paragraphs, and sentences). At the sentence level, we can have ambiguities in phrases (e.g., prepositional phrase attachment), words, anaphora, and, in the case of spoken text or dialogue, intonation. As we interpret text that we read or hear, possible misunderstandings will become clear and be resolved, maybe with help from our conversational partner. Earlier, we gave an example of ambiguity that occurred because a prepositional phrase could be attached to a syntactic construct (a verb, a noun phrase) in more than one way.

In this particular example we look at deliberate erroneous anaphora resolution to generate a HA. One problem in natural language processing is anaphoric reference. Anaphorically used words are words that are referring back to something that was earlier mentioned or that is known because of the discourse situation and/or the text as it is read or heard. The anaphorically used word is called "the anaphor", the word or phrase to which it refers "the antecedent". The extra lingual entity they co-refer to is called



Figure 2.3 Attempt at anaphora resolution in a Dilbert cartoon. Syndicated by Bruno Publications B.V

“the referent”. Anaphora resolution is the process of determining the antecedent of an anaphor. The antecedent can be in the same sentence as the anaphor, or in another sentence. Incorrect resolution of anaphoric references can be used in order to create a humorous remark in a dialogue situation. Consider for example the text used in a Dilbert cartoon (see Figure 2.3) where a new “Strategic Diversification Fund” is explained in a dialogue between the Adviser and Dilbert.

ADVISER: “Our lawyers put your money in little bags, then we have trained dogs bury them around town.”

How to continue from this utterance? Obviously, here, in the cartoon, we are dealing with a situation that is meant to create a joke, but all the elements of a non-constructed situation are there too. What are these dogs doing? Burying lawyers or bags? So, a continuation could be:

DILBERT: “Do they bury the bags or the lawyers?”

Surely, this Dilbert question is funny enough, although from a natural-language processing point of view it can be considered as a clarifying question, without any attempt to be funny. There is an ambiguity – that is, the system needs to recognize that generally dogs don’t bury lawyers and therefore “them” is more likely to refer to bags than to lawyers. Dogs can bury bags, dogs don’t bury lawyers.

We need to be able to design an algorithm that is able to generate this question at this particular moment in the dialogue. However, the system should nevertheless know that certain solutions to this question are not funny at all. It can take the most likely solution, from a common-sense point of view, but certainly this is not enough for our purposes. Here, “them” is an anaphor referring to a previous noun phrase. Its antecedent can be found among the noun phrases in the first sentence. Many algorithms for anaphora resolution are available and generally they come up with a solution that satisfies as many constraints as can be extracted from the sentence (gender, number, recency, emphasis, verb properties, order of words, etc.). We need, however, algorithms for anaphora resolution that decide to take a wrong but humorous solution, that is, a solution that does not necessarily satisfy all the constraints. And, preferably, violating one particular constraint should lead to the determination of an antecedent that, combined with the more obvious antecedent, leads to a question in which both of them appear, as in “Do they bury the bags or the lawyers?”

From a research viewpoint, the advantage of looking at such a simple, straightforward humorous remark is that we can confine ourselves to just one sentence. So, rather than having to look at scripts, frames, and other discourse representations, we can concentrate on the syntactic and semantic analysis of just one sentence. For this analysis, we can use well-known algorithms that transform sentences into

feature structure representations and issues such as script overlap and script opposition turn into properties of feature sets.

Contrast and inappropriateness are global terms from (not yet formalized) humor theory. In our approach, determining contrast translates into a heuristic that considers a potentially humorous antecedent and decides to use it because it has many properties in common with the correct antecedent. However, at least one salient property distinguishes the two potential antecedents (a shop window versus a dressing room, a bicycle versus a car, a bag versus a lawyer). A possible approach checks for inappropriateness by looking at constraints associated with the verb's thematic roles in the sentence. For example, these constraints distinguish between animate and inanimate; hence, burying lawyers who are alive is inappropriate. Obviously, more can be said about this. For example, professions or groups for which negative stereotypes exist are often grateful targets of jokes.

2.5.3 *Implementation and Experiments*

As mentioned earlier, when looking at the fundamental problems in humor research, we must wait until the main problems in artificial intelligence (AI) have been solved and then can apply the results to humor understanding and humor applications. This means, *inter alia*, that we have to wait until we are able to model "all" common-sense knowledge and the ability to reason with it. Clearly, it is more fruitful to investigate humor itself and see whether solutions that are far from complete and perfect can nevertheless find useful applications. In games and entertainment computing, natural interaction with ECAs for example requires humor modeling. Although many forms of humor don't fit into our framework of humorous misunderstandings, it can be considered a useful approach since it allows us to make the problems rather clear.

Current humor research has many shortcomings, which are also present in the approach discussed in the previous subsection. In particular, the conditions such as contrast and inappropriateness that have been mentioned might be necessary, but they are far from sufficient. Further pinpointing of humor criteria is necessary. Our approach has as starting point well-known theories from computational linguistics rather than trying to put linguistics, psychology and sociology in a comprehensive framework from which to understand humor.

In (Tinholt and Nijholt 2007) a design, an implementation, and experiments are reported that follow the viewpoints and ideas expressed above, in particular the approach to humorous anaphora resolution. This approach has been implemented in a chatbot. One reason to choose a chatbot is that its main task is to get a conversation going. Hence, it might miss opportunities to make humorous remarks, and when an intended humorous remark turns out to be misplaced, this isn't necessarily a problem. An attempt to embed pun-making in the conversational ability of a chatbot has been reported earlier (Loehr 1996). However, unlike our approach, in that case the proposed link between the contents of the pun and the interaction history was very poor.

Implemented algorithms for anaphora resolution are already available. We have chosen a Java implementation (JavaRAP) of the well-known Lappin and Leass' Resolution of Anaphora Procedure (1994). We obtained a more efficient implementation by replacing the embedded natural-language parser with a parser that has been made available to the research community by Stanford University. Experiments were designed to find ways to deal with anaphora-resolution algorithms' low success rate and to consider the introduction of a reliability measure before proceeding with possible antecedents of an anaphor. Other issues we are investigating are the different frequencies and types of anaphora in written and spoken text. In particular, we have been looking at properties from the anaphora viewpoint of conversations with well-known chatbots such as ALICE, Toni, Eugene, and Jabberwocky. Resources that are investigated are publicly available knowledge bases such as WordNet, WordNet Domains, FrameNet, VerbNet, and ConceptNet. For example, in VerbNet, every sense of a verb is mapped to a verb class representing the conceptual meaning of this sense. Every class contains both information on the thematic roles associated

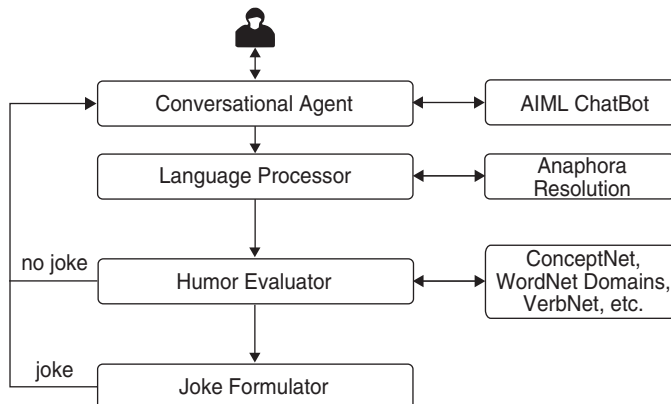


Figure 2.4 Architecture of the humorous anaphora system

with the verb class and frame descriptions that describe how the verb can be used. This makes it possible to check whether a possible humorous antecedent of an anaphor sufficiently opposes the correct antecedent because of constraints that it violates. Unfortunately, because VerbNet only contains about 4500 verbs, many sentences cannot be analyzed.

In Figure 2.4 the four modules that form our system are shown. The “conversational agent” is responsible for receiving input from the user and keeping the conversation with the user going. It forwards all input from the user to the rest of the system. If the system indicates that an anaphora joke can be made, then the conversational agent will make this joke. Otherwise, the conversational agent uses an AIML (Artificial Intelligence Mark-up Language)-based chatbot (Wallace *et al.* 2003) to formulate a response to the user. If the system cannot make an anaphora joke, it uses the reactions of the chatbot. The analysis whether a user utterance contains humorous anaphora ambiguities is done by the “language processor” and the “humor evaluator”. In the language processor an adjusted version of JavaRAP is used that locates every pronominal anaphor in the text and returns all antecedents that are not excluded based on eliminating factors like gender and number agreement. If at least two possible antecedents are found, the anaphoric expression is ambiguous and this information is forwarded to the humor evaluator to check whether this ambiguity is humorous.

The humor evaluator implements the check for contrast, described earlier. Roughly this comes down to comparing the real antecedent of the anaphor to the possible other candidate(s). The properties of possible antecedents are retrieved from ConceptNet and they are compared. If there is an acceptable antecedent with a sufficient number of properties in common with the real antecedent and the non-overlapping properties contain at least one pair of antonymous properties, then they are considered to be in contrast. In this implementation we don’t perform tests on inappropriateness or taboo. Hence, based on contrast an utterance is generated by the joke formulator, where the (hopefully successful) joke is a simple clarification request that indicates that the anaphoric reference was deliberately misunderstood. In our Dilbert example, the conversational agent is expected to return “The lawyers were buried?”

The system was evaluated by having it analyze a chatbot transcript and a simple story text (Tinholt and Nijholt 2007). It turned out that humorous cross-reference ambiguity was rare. The system was able to make some jokes, but its performance was also very moderate due to the available tools. There is imperfect parser output, the anaphora resolution algorithm is not perfect and has to work with this imperfect output of the parser. In addition, errors are caused by the sparseness of ConceptNet. For these reasons we think that our approach does provide future prospects in generating conversational humor but

that for the moment we have to wait for more elaborated versions of ConceptNet or similar resources and for better parsers and anaphora resolution algorithms.

2.5.4 Discussion

Although we have not seen humor research devoted to erroneous anaphora resolution, the approaches in computational humor research in general are not that different from what we saw in the examples presented here. The approaches are part of the incongruity-resolution theory of humor. This theory assumes situations – either deliberately created or spontaneously observed – where there is a conflict between what is expected and what actually occurs. Ambiguity plays a crucial role. Phonological ambiguity, for example in certain riddles, syntactic ambiguity, semantic ambiguity of words, or events that can be given different interpretations by observers. Due to the different interpretations that are possible, resolution of the ambiguity may be unexpected, especially when one is led to assume a “regular” context and only at the last moment it turns out that a second context allowing a different interpretation was present as well. These surprise disambiguations are not necessarily humorous. Developing criteria to generate humorous surprise disambiguations only is one of the challenges of humor theory. Attempts have been made, but they are rather primitive. Pun generation is an example (Binsted and Richie 1997), acronym generation another (Stock and Strapparava 2003). In both cases we have controlled circumstances. These circumstances allow the use of WordNet and WordNet extensions and reasoning over these networks, for example, to obtain a meaning that does not fit the context or is in semantic opposition of what is expected in the context. No well-developed theory is available, but we see a slow increase in the development of tools and resources that make it possible to experiment with reasoning about words and meanings in semantic networks, with syllable and word substitutions that maintain properties of sound, rhyme or rhythm and with some higher-level knowledge concepts that allow higher-level ambiguities.

2.6 Nonverbal Support for Humorous Acts

2.6.1 Introduction

Being allowed to look at computers as social actors also allows us to have more natural interaction and it allows us to influence the interaction on aspects of emotions, trust, personality, attraction, and enjoyment. Interest in these issues grew with the introduction of embodied agents in the interface and the opportunity to add nonverbal cues to support the interaction and to display emotions and individual characteristics in face, body, voice, and gestures. For example, the role of small talk for inducing trust in an embodied real estate agent has been discussed in Cassell *et al.* (2001). The development of long-term relationships with a virtual personal assistant has been discussed in Bickmore and Cassell (2001) and in Bickmore (2003), and in Stronks *et al.* (2002) we presented a preliminary discussion on friendship and attraction in the context of the design and implementation of ECAs.

Facial expressions and speech characteristics have received most of the attention in research on nonverbal communication behavior. Emotion display has become a well-established area, very much stimulated by available theories of emotions on the one hand and theories of human facial expressions and speech intonation on the other hand. It is certainly the case that humor appreciation is associated with positive emotions.

Hardly any research is available on generating accompanying nonverbal behavior in humorous human–human communication. Consequently, there is not yet much research going on in nonverbal issues for embodied agents that interpret or generate humor in the interface. There is, however, a growing interest in translating attainments from social psychology research in face-to-face behavior to the human–ECA situation. Displaying appreciation of humor in face or voice is an issue that, however, has received some attention.

In this section we survey the different approaches in the literature to nonverbal communication by ECAs with, of course, an emphasis on those approaches that seem to be important from a humor generation point of view.

2.6.2 *Nonverbal HA Display*

In this chapter, the assumption is that it is useful to have ECAs generate humorous remarks. That is, we have ECAs as transmitters that generate HAs and accompanying nonverbal behavior, rather than as hearers or recipients of humorous remarks made by their human conversational partners. Unfortunately, not much can be said about accompanying nonverbal behavior during HA generation. The speaker may enjoy creating and making a humorous remark, but may decide to hide this in order to increase the effect of the act. Spontaneous act generation may be accompanied by displaying an enjoyment emotion in the face and the gestures that are made. Generation may be followed by some nonverbal acknowledgement that a change has been made to a non-bona-fide mode of communication, such as a smile, a particular gesture, a wink or, more likely, a combination of these modalities.

How will an ECA show enjoyment in voice and face? Laughs, smiles or more subtle expressions of enjoyment can be modeled in the expressions an ECA can display in the face and in the voice. See Kappas *et al.* (1991), for example, for a discussion on cues that are related to detecting and generating enjoyment in the voice. From the speech point of view the vocalization of laughter is another interesting issue for ECAs.

Ekman (1985) distinguishes between eighteen different smiles and functions ascribed to them. A smile can be a greeting; it can mean incredulity, affection, embarrassment or discomfort, to mention a few. Smiling does not always accompany positive feelings. The different functions make it important to be able to display the right kinds of smiles at the right time on the face of an ECA. Should it display a felt smile because of a positive emotional experience, should it take the harsh edge of a critical remark, or is it meant to show agreement, understanding or intention to perform?

Frank and Ekman (1993) discuss in some more detail the “enjoyment” smile, the particular type of smile that accompanies happiness, pleasure, or enjoyment. The facial movements that are involved in this smile are involuntary; they originate from other parts in the brain than the voluntary movements and have a different manifestation. Morphological and dynamic markers have been found to distinguish enjoyment smiles from others. The main, best-validated marker is known as the Duchenne marker or Duchenne’s smile, the presence of orbicular oculi action (the muscle surrounding the eyes) in conjunction with zygomatic major action (muscles on both sides of the face that pull up the mouth corners). Although some people can produce it consciously, the Duchenne marker is one of the best facial cues for deciding enjoyment¹ and therefore an ECA should show it in the case of sharing humorous events with its human partner. For a survey of hypotheses and empirical findings regarding the involvement of muscles in the laughter facial expression, see Ruch and Ekman (2001). Laughter also involves changes in posture and body movements. Again, we need to distinguish between different types of laughter (spontaneous, social, and suppressed).

2.6.3 *Showing Feigned or Felt Support?*

In applications using ECAs we have to decide which smiles and laughs to use while interacting with a human conversational partner. When a virtual teacher smiles, should it be a Duchenne smile? Is the

¹ The timing of the onset and offset phase are other cues that signal the distinction between a deliberate and a spontaneous smile.

embodied agent “really” amused or does it only display a polite smile because it does not really like the joke made by its human conversational partner? Or should it not laugh or smile at all because of a politically incorrect joke? As mentioned by Cowie (2000):

People respond negatively to displays of emotion that are perceived as simulated, and that is a real issue for agents that are intended to convey emotion.

Will our attempts to introduce believability not be hampered by the impossibility to convey emotions in a believable way? Maybe we accept poor-quality speech synthesis, maybe we accept poor-quality facial expression (compared with human speech and human facial expressions), but will we accept the same for emotion display, in particular display related to an appreciation of a humorous event conveyed through these channels? Note, that when we talk about a humorous event we include events that appear in a story being told by a virtual agent in interaction with a human conversational partner, events that are interpreted from a sequence of utterances in a dialogue, events that are visualized in a virtual environment, or events that need interpretation of integrated virtual and real-life interactions.

In our view these issues are not different from other observations on believability of embodied agents. In some situations, assuming that quality allows it, a synthesized voice or face may express acted pleasure (or anger), in other situations genuine pleasure (or anger). Whether it sounds or looks sincere depends on being able to suspend disbelief in the human partner of the agent. Interesting in this respect is the work of Marquis and Elliott (1994) who discuss research on embodied poker-playing agents (with a human partner) that can deliberately display false emotions in the face and in the voice.

Humor, when generated by an ECA with appropriate nonverbal display, can help in establishing a sense of well-being by its human partner and this can make it easier to persuade the human partner to make certain decisions or to perform certain actions. This can be for the “good” (persuading someone to continue a fitness program) or for the “bad” (persuading someone to buy goods he or she doesn’t really want) of the human partner. Being able to design ECAs that manipulate their human partners requires attention for ethical issues.

2.6.4 Humor, Culture, and Gender

National and cultural differences in humor appreciation have been investigated. Differences were observed, but most authors agree that one should be very careful with interpretation of results because of uncertainty of the samples, low significance in the results, possible differences between humor production and humor appreciation and what has been rated (cartoons, written or spoken jokes), and what humor taxonomies have been used. There is certainly no agreement about definitions of humor classes and there is no agreement in which category to put a certain joke. Some differences that have been mentioned: higher appreciation of sexual humor and lower appreciation of nonsense humor was found for Italian adults when compared with German adults Ruch and Forabasco (1994); unlike students from Belgium and Hong Kong, US students preferred jokes with sexual and aggressive contents Castell and Goldstein (1976); Singaporean students supply a greater number of aggressive jokes and fewer jokes with sexual content than American students (Reeves and Nass 1996); and so on.

There are also gender differences in humor behavior. Again, as we mentioned above, it is not wise to generalize from results obtained in a particular experiment. We observe that in several studies it has been reported that males enjoy self-bragging jokes more than females (Tannen 1994; Chao-chih Liao 2003). It has also been reported that men have a larger repertoire of jokes, enjoy joke telling more than women do, and score higher on humor creation. Women often show more appreciation of jokes than men do. Males enjoy sexual humor more than females, but there are also differences when looking at explicitness (high or low) and the victims of sexual jokes. In the research there are sometimes straightforward conflicting results (Herzog 1999).

Studies also show that there is an anti-feminine bias in humor. See, for example, Lampert and Ervin-Trip (1998) for a review of gender differences in humor behavior, including possible changes. Because of gender roles in society and because of social changes in gender roles we need to be very careful in translating properties in real life to the design of embodied agents that create or appreciate humor.

2.7 Methods, Tools, Corpora, and Future Research

2.7.1 Introduction

When discussing humor research for ECAs and its future development it is useful to distinguish between methods, tools and resources for verbal HA generation and methods and tools that help to have ECAs generate and display HAs using nonverbal communication acts. Nowadays, graphics, animation and speech synthesis technology make it possible to have embodied agents that can display smiles, laughs and other signs of appreciation of the interaction or humorous remarks included in the interaction. Current ECA research, however, hardly pays attention to these issues. Facial expressions are often confined to the display of some basic emotions and subtleties of different smiles are not considered. Especially the display of laughter at appropriate moments will not only meet research challenges about appropriateness, but also challenges in speech synthesis and in facial animation. Current multimodal and affective markup languages need to be extended and detailed in order to include the multimodal presentation of humorous acts in ECA behavior.

2.7.2 Corpora, Annotation Schemes, and Markup Languages

Corpora are needed in order to study the creation of HAs in dialogues and naturally occurring conversations, including conversations that make references to common knowledge, task and domain knowledge, conversation history, and the two- or three-dimensional visualized context of the conversation. By visualized context we mean the ECA and its environment (e.g., a reception desk, a lounge, posters in the environments, a particular training environment, other ECAs, including users and visitors, etc.).

There is a wealth of material available in existing corpora that have been collected, mostly for quite different purposes than for doing humor research. There are corpora that have been collected and annotated for research on dialogue modeling (sometimes obtained from Wizard of Oz experiments) or on dialogue act prediction, there are corpora for specific multimodal tasks that have to be performed, there are corpora of spontaneous conversations, and there are corpora of recorded interactions where the emphasis is on gestures and facial expressions. Transcripts of dialogues and conversations allow investigating when and why humorous acts were created and when there was the opportunity to create a humorous act. That is, which elements of the discourse have been used or could have been used in order to construct a humorous act? Clearly, in goal-directed dialogues we will see less HAs than in naturally occurring conversations that are open-ended, contain many topic shifts, and are also held to maintain a relationship. Hence, it is useful to distinguish between different kinds of domains and tasks when considering corpora that can be used for humor research.

Many corpora have been collected and there are also many initiatives to make them available to researchers. One example is the Linguistic Data Consortium (LDC; <http://www ldc.upenn.edu/>), a foundation taking responsibility for making available hundreds of meeting recordings, telephone conversations, and interviews. Many corpora are available where users are asked to plan a trip, rent a car and arrange a hotel. From the so-called Map Task experiments corpora have been collected where two participants engage into a cooperative dialogue to find out how to go from one place to another. Both participants have maps of the environment, but they differ in showing landmarks that can be used for a verbal description of a route. In our own research we collected, using Wizard of Oz experiments, dialogues where the human partner is asking information about theatre performances, performers, dates and locations in

natural language. In these examples, most of the interaction is about goal-directed dialogues, rather than on naturally occurring interactions during a conversation. For humor research more corpora are needed containing naturally occurring conversations.

Well known annotation schemes have been introduced to describe and distinguish (verbal) dialogue acts. For example, there is DAMSL (Dialog Act Markup in Several Layers), a scheme that has been developed to annotate two-agent task-oriented dialogues. In the dialogue the agents are supposed to collaborate to solve some problem. In the DAMSL scheme, utterance tags, indicating some particular aspect of the utterance, are assigned to the utterances in the dialogue. The main categories for the tags are the Communicative Status (it records whether the utterance is intelligible and whether it was successfully completed), the Information Level (a characterization of the semantic content of the utterance), the Forward Looking Function (how the current utterance constrains the future beliefs and actions of the participants, and affects the discourse), and the Backward Looking Function (how the current utterance relates to the previous discourse). Although we can emphasize that our interest is in naturally occurring conversations, it is certainly the case that these annotation schemes can be employed to get a grip on models that attempt to include humor appreciation and humor generation acts.

When we turn our attention to corpora that allow us to study nonverbal communication behavior, we first observe that in previous decades it was much easier to collect texts and transcriptions of dialogues and conversations, than to collect easily accessible and manipulatable data on nonverbal communication acts. Rather than digitalized videos of naturally occurring events, researchers had to use transcriptions of videos and pictures of attempts to simulate events. Only in the last decade we see the collecting of recordings of displays of facial expressions, gesture and body posture during experiments. Instead of having to access analogue speech or video data in sequential ways, now we have the possibility to access, select and manipulate data that has been stored digitally. However, unlike what has become usual in speech and language corpora, there are not yet internationally agreed ways of consistently storing such data and agreed ways of making it accessible, for example for research purposes.

Audio-visual data corpora are needed to analyze the role of nonverbal communication acts in HA generation in interaction with verbal communication acts. In corpus research, observations are followed by analysis, analysis tries to confirm ideas, and the results are theories of recognition and interpretation, including learning strategies. Through annotation schemes there is interaction between analysis, restructuring the corpus, and theory building. In this process corpus annotation schemes play an essential role. They connect top-down theory building and bottom-up descriptions of events.

Audio-visual data corpora allow us to analyze captured data about gestures, postures, facial expressions, and speech from a HA generation point of view. We also need tools for model-based annotations, where the models have been designed to include a humor point of view. Those models are not yet available. Nevertheless, we can look at multimodal annotated corpora that include verbal and nonverbal communication acts. Annotation of such corpora allows representation, analysis and synthesis of theory-based characteristics. In this way, annotation tools and annotated corpora have been developed and made available for facial actions and expressions (using the Facial Action Coding System: FACS), visual speech, conversational gestures, deictic gestures, hand shapes, and intonation. Often they build upon tools developed for annotating and retrieving information from spoken language corpora. Video annotation tools (Anvil, FORM) and workbenches (for example, developed in the European NITE project or the German SmartKom project) have been designed for multi-level, cross-level and cross-modality annotation of natural activity. These tools allow annotations from very detailed, on the signal level, to holistic. The former allows, for example, the description of eye aperture and eyelid movements, including duration and intensity aspects; the latter can be found in the SmartKom user-state coding systems, where both the cognitive and the emotional state are labeled (Steinger *et al.* 2002).

From the ECA generation point of view, models that underlie annotation languages can as well be employed in markup languages that define ECA display of natural interaction, such as in the XML-based markup language for affective display APML (Affective Presentation Markup Language) designed by Pélachaud and Poggi (2002), EMOTE (2000), and BEAT (2001). In APML, for example, we have

various face markers (e.g., affective), functional values (e.g., joy as one of the affective markers) and signals (e.g., smile and raised cheek for the functional value joy). A match between annotations and display acts makes it possible, assuming the availability of needed visualization and animation tools, to play back an annotation in order to judge how well phenomena have been captured.

Until now, hardly any experiments can be reported that have been performed from the point of view of embodied humor research and that aimed at building a corpus containing data to be explored from the point of view of humor research, that is, giving attention to analysis, annotation, training of recognition, and generation for humor research and application purposes. However, there have been experiments that, indeed, have been performed for quite different reasons, and that can be used for embodied humor research. Making use of corpora available from emotion research, we can investigate how humor-related emotions (e.g., enjoyment and confusion) are displayed in face, gesture, intonation, and posture. How it is displayed with a choice of dialogue act, utterance, words, and intonation is too far away from current research.

As an example of research performed for quite different reasons than humor research we mention the corpus collected by Hill and Johnston (2001) where they have more than 200 recordings of the facial movements of twelve men and women telling jokes. The aim of their research was to investigate distinctions between male and female facial and head movements. Can a computer make this distinction; that is, in our situation, will an ECA be able to decide from its perception of just these movements that it is communicating with a man or a woman?

The facial movements in the Hill and Johnston corpus were obtained from a two-line question-and-answer joke told to another individual (“Why do cows have bells? Because their horns don’t work!”). They used motion-capture with two cameras and many markers on the forehead, temples and nose to recreate the facial movements in an average three-dimensional head of an embodied conversational agent (Figure 2.5). During a conversation or dialogue, having a particular HA or joke schema, an ECA can detect the appropriate moment to generate a particular type of joke or HA and it can use the average three-dimensional head movements to display the joke using verbal and nonverbal humor features.

Average nonverbal communication behavior as described in the previous paragraphs can be adapted by adding personality and emotional characteristics features. See Ball and Breese (2000), linking emotions and personality to nonverbal behavior using Bayesian Networks. In (Allbeck and Badler 2002), the emphasis is on adapting the gestures of ECA to its personality and gestures features.



Figure 2.5 Finding the average head in joke telling

2.7.3 Future Research Approaches

In the line of research on autonomous (intelligent and emotional) agents we need an ECA to understand why the events that take place generate enjoyment by its conversational partner and why it should display enjoyment because of its partner's appreciation of a HA. That is, models are needed that allow generation, prediction, detection, and interpretation of humorous events.

What events need to be distinguished, how does the ECA perceive them, and how does it integrate them at a semantic and pragmatic level of understanding of what is going on? There are two approaches to this question when we look at state-of-the-art research. One approach deals with speech and dialogue act prediction. What is going to happen next, given the history and the context of the dialogue? Can an ECA predict the next dialogue act by its conversational partner or can it compute the next dialogue act that is expected by its (i.e., the ECA's) conversational partner? Previous and possibly future dialogue acts are events that need to be "appraised". In earlier research (Keizer *et al.* 2002) we used Bayesian networks in order to predict dialogue acts. While this approach is unconventional from the usual point of view of event appraisal, it is an accepted approach in dialogue modeling research that has been implemented in a number of dialogue systems. Some attempts have been made to introduce multimodal dialogue acts. It seems to be useful to introduce more refined dialogue acts that take into account the willingness of a conversational partner to construct a humorous utterance and that take into account the possibility to give interpretations to (parts of) previous utterances that may lead to humorous acts. Obviously, in order to be able to do so we need corpora of natural conversations that allow us to design, train and test algorithms and strategies. Holistic user-state modeling, as advocated in the previously mentioned SmartKom project, is a possible way to obtain data from which recognition algorithms can be designed.

Clearly, with such an approach we enter the area of emotion research. One of its viewpoints is that of appraisal theory, the evaluation of events and situations followed by categorizing arising affective states. Some of the theories that emerged from this viewpoint have been designed with computation in mind: designing a computational model to elicit and display emotions in a particular situation. A mature theory for calculating cognitive aspects of emotions is the OCC model (Ortony *et al.* 1988), a framework of 22 distinct emotion types. A revised version, presented in the context of believable ECA design was given in Ortony (2001). Can we make a step from event appraisal theories for deciding an appropriate emotion to appraisal theories for deciding the appropriateness of constructing a humorous act? As mentioned, issues that should be taken into account are the ability to construct a HA using elements of the discourse and the appropriateness of generating a HA in the particular context. In human-computer interaction applications some (mostly, stripped-down) versions of the model have been used. Examples are the OZ-project (Reilly and Bates 1992), concerned with the development of a theater world inhabited by emotional agents, and the Carmen project (Marsella *et al.* 2000), where event appraisal is used to recognize feelings of guilt and anger in a setting where an embodied agent talks with a mother of children with leukemia.

It seems also useful to review existing theories and observations concerning the appraisal of (humorous) situations (available as events, in conversations, in verbal descriptions or stories) in terms of possible agent models that include explicit modules for beliefs, desires, intentions, and emotions. Beliefs, desires and intentions (goals) define the cognitive state of an agent. Because of perceptive events, state changes take place. From the humor modeling point of view, agent models of states and state changes need to include reasoning mechanisms about situations where there is the feeling that on the one hand the situation is normal, while at the same time there is a violation of a certain commitment of the agent about how things ought to be. From a humor point of view, relevant cognitive states should allow detection of surprise, incongruity, and reconstruction of incongruity using reasoning mechanisms (Mele 2002). With this view in mind it is useful to look at the violation theory discussed in Veatch (1998), attempts to define degrees of incongruity (Deckers 2001), attempts to define humor in terms of violations of Grice's conversational maxims (Attardo 1993, 1997), and proposals to define and explain humor or laughter in terms of perceptual, affective, and response patterns (Russell 2000).

2.8 Conclusions

This chapter touches upon the state of the art of embodied conversational agents, humor modeling, and affective computing. Using the “computers are social actors” paradigm we made clear that it is useful for natural interaction between human and computer to introduce characteristics of human–human interaction in agent–human interaction, including the generation of humor and the display of appreciation of humor. We introduced the notion of a humorous act in a dialogue or in a conversation. We certainly were not able to give general algorithms for construction of humorous acts or for deciding when to generate a humorous act in a dialogue or conversation. Rather we discussed the issues involved and we presented examples. The first steps towards the implementation of a chatbot constructing humorous acts during a conversation were also presented. Picard and Klein (2002) mentioned that increasingly people spend more time communicating with each other via technology without sufficient affect channels. They argue that this may reduce people’s emotional skills and a solution might be to design computers that appropriately support users in handling their emotions. Clearly, a similar argument can be given for a “humor channel” that is lacking in human–computer and computer-mediated interaction. Humor especially appeals to positive emotions and therefore can make human–computer interaction more enjoyable.

Acknowledgments

Part of the research reported in this chapter was supported by the European Future Emerging Technologies (FET) assessment project HAHAcronym (IST-2000-30039), a joint project of ITC-IRST (Trento) and the University of Twente. This chapter is based on two earlier workshop papers (Nijholt *et al.* 2002; Nijholt 2005) and a journal paper (Binsted *et al.* 2006). I am grateful to my student Matthijs Mulder for help in finding and summarizing relevant literature, and my student Hans Wim Tinholt for his work towards implementing our approach to humorous anaphora resolution. Permissions to use the illustrations in this chapter were obtained from Jonathan Gratch of ICT, Marina del Rey (Figure 2.1), Catherine Pélachaud of the Université de Paris (Figure 2.2), United Media, New York (Figure 2.3), and Harold Hill of University College London (Figure 2.4).

References

- Adelswärd V. and Öberg B.-M. (1998) The function of laughter and joking in negotiation activities. *Humor: International Journal of Humor Research* **11** (4), 411–429.
- Allbeck J. and Badleron N. (2002) Toward representing agent behaviors modified by personality and emotion. Workshop on Embodied conversational agents – let’s specify and evaluate them! AAMAS 2002, Bologna, Italy.
- Attardo S. (1993) Violations of conversational maxims and cooperation: the case of jokes. *Journal of Pragmatics* **19** (1), 537–558.
- Attardo S. (1996) Humor. In J. Verschueren, J.-O. Ostman, J. Blommaert and C. Bulcaen (eds), *Handbook of Pragmatics*. John Benjamins Publishing Co., Amsterdam/Philadelphia, pp. 1–17.
- Attardo S. (1997) Competition and cooperation: beyond Gricean pragmatics. *Pragmatics and Cognition* **5** (1), 21–50.
- Ball G. and Breese J. (2000) Emotion and personality in a conversational agent. In J. Cassell, J. Sullivan, S. Prevost and E. Churchill (eds), *Embodied Conversational Agents*. MIT Press, Cambridge, MA.
- Bates J. (1994) The role of emotion in believable agents. CMU-CS-94-136, Carnegie Mellon University, Pittsburgh; also: *Communications of the ACM*, Special Issue on Agents, July 1994.
- Bickmore T. (2003) Relational Agents: Effecting Change through Human-Computer Relationships. MIT Ph.D. Thesis, MIT, Boston, 2003.
- Bickmore T. and Cassell J. (2001) Relational agents: a model and implementation of building user trust. In *Proceedings of ACM CHI 2001*, Seattle, Washington, pp. 396–403.
- Binsted K. (1995) Using humor to make natural language interfaces more friendly. In Proceedings of AI, ALife, and Entertainment Workshop, International Joint Conference on Artificial Intelligence, 1995.

- Binsted K. and Ritchie G. (1997) Computational rules for punning riddles. *Humor: International Journal of Humor Research* **10** (1).
- Binsted K., Bergen B., Coulson S., Nijholt A., Stock O., Strapparava C., Ritchie G., Manurung R., Pain H., Waller A. and O'Mara D. (2006) Computational humor. *IEEE Intelligent Systems* **21** (2), 59–69.
- Cann A., Calhoun L.G. and Banks J.S. (1997) On the role of humor appreciation in interpersonal attraction: it's no joking matter. *Humor: International Journal of Humor Research* **10** (1), 77–89.
- Cassell J., Vilhjalmsson H. and Bickmore T. (2001) Beat: the behavior expression animation toolkit. In *Proceedings of ACM SIGGRAPH*, pp. 477–486.
- Castell P.J. and Goldstein J.H. (1976) Social occasions of joking: a cross-cultural study. In A.J. Chapman and H.C. Foot (eds), *It's a Funny Thing, Humour*. Pergamon Press, Oxford, pp. 193–197.
- Chao-chih Liao (2003) Humor versus Huaji. *Journal of Language and Linguistics* **2** (1), 25–50.
- Chi D., Costa M., Zhao L. and Badler N. (2000) The emote model for effort and shape. In *Proceedings of ACM SIGGRAPH*, New Orleans, LA, pp. 173–182.
- Consalvo C.M. (1989) Humor in management: no laughing matter. *Humor: International Journal of Humor Research* **2** (3), 285–297.
- Cowie R. (2000) Describing the emotional states expressed in speech. In *Proceedings of the ISCA Workshop on Speech and Emotion*. Belfast, pp. 11–18.
- Deckers L. (2001) On the validity of a weight-judging paradigm for the study of humor. *Humor: International Journal of Humor Research* **6** (1), 43–56.
- Ekman, P. (1993) Facial expression of emotion, *American Psychologist* **48** (4), 384–392.
- Ekman P. (1985) *Telling Lies: Clues to deceit in the market place, politics, and marriages*. New W.W. Norton, New York. Reissued in 2001 with a new chapter.
- Frank M.G. and Ekman P. (1993) Not all smiles are created equal: the differences between enjoyment and nonenjoyment smiles. *Humor: International Journal of Humor Research* **6** (1), 9–26.
- Friedman B. (ed.) (1997) *Human Values and the Design of Computer Technology*. Cambridge University Press, Cambridge.
- Fry P.S. (1995) Perfection, humor, and optimism as moderators of health outcomes and determinants of coping styles of women executives. *Genetic, Social, and General Psychology Monographs* **121**, 211–245.
- Grice P. (1989) Logic and conversation. In H. P. Grice (ed.), *Studies in the Way of Words*. Harvard University Press, Cambridge, MA, pp. 22–40.
- Hampes W.P. (1999) The relationship between humor and trust. *Humor: International Journal of Humor Research* **12** (3), 253–259.
- Hartmann B. Mancini M. and Pélachaud C. (2005) Implementing expressive gesture synthesis for embodied conversational agents. Gesture Workshop, Lecture Notes in Artificial Intelligence, Springer, May 2005.
- Hay J. (2001) The pragmatics of humor support. *Humor: International Journal of Humor Research* **14** (1), 55–82.
- Herzog T.R. (1999) Gender differences in humor appreciation. *Humor: International Journal of Humor Research* **12** (4), 411–423.
- Hill H. and Johnston A. (2001) Categorizing sex and identity from the biological motion of faces. *Current Biology* **11**, 880–885.
- Kappas A. Hess U. and Scherer K.R. (1991) Voice and emotion. In R.S. Feldman, *et al.* (eds), *Fundamentals of Nonverbal Behavior*. Cambridge University Press, Cambridge, pp. 200–237.
- Keizer S., Akker R. op den, and Nijholt A. (2002) Dialogue act recognition with Bayesian networks for Dutch dialogues. In K. Jokinen and S. McRoy (eds), *Proceedings 3rd SIGdial Workshop on Discourse and Dialogue*, Philadelphia, Pennsylvania, pp. 88–94.
- Klein J., Moon Y. and Picard R.W. (2002) This computer responds to user frustration: theory, design, and results. *Interacting with Computers* **14** (2), 119–140.
- Lampert M.D. and Ervin-Tripp S.M. (1998) Exploring paradigms: the study of gender and sense of humor near the end of the 20th century. In W. Ruch (ed.), *The Sense of Humor: Explorations of a Personality Characteristic*. Mouton de Gruyter, Berlin, pp. 231–270.
- Lappin S. and Leass H. (1994) An algorithm for pronominal anaphora resolution. *Computational Linguistics* **20** (4), 535–561.
- Lester J.C., Converse S.A., Kahler S.E., Barlowe S.T., Stone B.A. and Bhogal R. (1997) The persona effect: affective impact of animated pedagogical agents. *Proceedings CHI '97: Human Factors in Computing Systems*, ACM, pp. 359–356.

- Loehr D. (1996) An integration of a pun generator with a natural language robot. In J. Hulstein and A. Nijholt (eds), *Computational Humor*. University of Twente, Enschede, pp. 161–171.
- Marsella S.C., Johnson W.L. and LaBore C. (2000) Interactive pedagogical drama. In *Proceedings 4th International Conference on Autonomous Agents*, ACM, pp. 301–308.
- Mele F. (2002) Deliverable on humor research: state of the art. European IST Project HaHacronym on Future Emerging Technologies, 2002.
- Morkes J., Kernal H. and Nass C. (2000) Effects of humor in task-oriented human–computer interaction and computer-mediated communication: a direct test of social responses to communication technology theory. *Human–Computer Interaction* **14** (4), 395–435.
- Nijholt A. (2002) Embodied agents: a new impetus to humor research. In O. Stock, C. Strapparava and A. Nijholt (eds), The April Fools Day Workshop on Computational Humor. *Proceedings Twente Workshop on Language Technology (TWLT 20)*, ITC-IRST, Trento, Italy, pp. 101–111.
- Nijholt A. (2005) Conversational agents, humorous act construction, and social intelligence. In: *Proceedings AISB: Social Intelligence and Interaction in Animals, Robots and Agents. Symposium on Conversational Informatics for Supporting Social Intelligence and Interaction: Situational and Environmental Information Enforcing Involvement in Conversation*, K. Dautenhahn (ed.). University of Hertfordshire, Hatfield, England, pp. 1–8.
- Norrick N.R. (1993) *Conversational Joking: Humor in Everyday Talk*. Indiana University Press, Bloomington, IN.
- Ortony A. (2001) On making believable emotional agents believable. In R. Trappl and P. Petta (eds), *Emotions in Humans and Artifacts*. MIT Press, Cambridge, MA.
- Ortony A., Clore G.L. and Collins A. (1988) *The Cognitive Structure of Emotions*. Cambridge University Press, Cambridge.
- Pélauchaud C. and Poggi I. (2002) Subtleties of facial expressions in embodied agents. *Journal of Visualization and Computer Animation*,
- Picard R.W. and Klein J. (2002) Computers that recognize and respond to user emotion: theoretical and practical implications. *Interacting with Computers* **14** (2), 141–169.
- Raskin V. (1985) *Semantic Mechanisms of Humor*. (Synthese Language Library 24). D. Reidel, Dordrecht.
- Reeves B. and Nass C. (1996) *The Media Equation: How people treat computers, televisions and new media like real people and places*. Cambridge University Press, Cambridge.
- Reilly W. and Bates J. (1992) Building emotional agents. Report CMU-CS-92-143, Carnegie Mellon University.
- Ritchie G. (1999) Developing the incongruity-resolution theory. *Proceedings of AISB Symposium on Creative Language: Stories and Humour*, Edinburgh, pp. 78–85.
- Ruch W. (1994) Extroversion, alcohol, and enjoyment. *Personality and Individual Differences* **16**, 89–102.
- Ruch W. and Ekman P. (2001) The expressive pattern of laughter. In A.W. Kaszniak (ed.), *Emotion, Qualia, and Consciousness*. Word Scientific Publisher, Tokyo, pp. 426–443.
- Ruch W. and Forabasco G. (1994) Sensation seeking, social attitudes and humor appreciation in Italy. *Personality and Individual Differences* **16**, 515–528.
- Russell R.E. (2000) Humor’s close relatives. *Humor: International Journal of Humor Research* **13** (2), 219–233.
- Shechtman N. and Horowitz L.M. (2003) Media inequality in conversation: how people behave differently when interacting with computers and people. *Proceedings SIGCHI-ACM CHI 2003: New Horizons*. ACM, pp. 281–288.
- Steininger S., Schiel F. and Glesner A. (2002) User-state labeling procedures for the multimodal data collection of SmartKom. *Proceedings of the 3rd International Conference on Language Resources and Evaluation*, Las Palmas, Spain.
- Stock O. (1996) Password Swordfish: verbal humor in the interface. In J. Hulstein and A. Nijholt (eds), *International Workshop on Computational Humor*, University of Twente, pp. 1–8.
- Stock O. and Strapparava C. (2003) An experiment in automated humorous output production. *Proceedings of the International Conference on Intelligent User Interfaces (IUI)*, Miami, Florida.
- Stronks B., Nijholt A., Vet P. van der, and Heylen D. (2002) Designing for friendship. In A. Marriott *et al.* (eds), *Proceedings of Embodied Conversational Agents: Let’s Specify and Evaluate Them!* Bologna, Italy, pp. 91–97.
- Tannen D. (1984) *Conversational Style: Analyzing talk among friends*. Ablex Publishing, Westport.
- Tannen D. (1994) *Talking from 9 to 5*. Avon Books New York.
- Theune M., Heylen D. and Nijholt A. (2005) Generating embodied information presentations. In O. Stock and M. Zancanaro (eds), *Multimodal intelligent information presentation*. Kluwer Academic Publishers, pp. 47–70.

- Tinholt H.W. and Nijholt A. (2007) Computational humour: utilizing cross-reference ambiguity for conversational jokes. In F. Masulli, S. Mitra and G. Pasi (eds), *Proceedings 7th International Workshop on Fuzzy Logic and Applications (WILF 2007)*, Camogli, Italy; Lecture Notes in Computer Science 4578, Springer-Verlag, Berlin.
- Veatch T. (1998) A theory of humor. *Humor: International Journal of Humor Research* **11** (2), 161–215.
- Wallace D.R., Tomabechi D.H. and Aimless D. (2003) Chatterbots go native: considerations for an eco-system fostering the development of artificial life forms in a human world. Manuscript.
- Zajdman A. (1991) Contextualization of canned jokes in discourse. *Humor: International Journal of Humor Research* **4** (1), 23–40.
- Zajdman A. (1992) Did you mean to be funny? Well, if you say so *Humor: International Journal of Humor Research* **5** (4), pp. 357–368.
- Ziv A. (1988) Teaching and learning with humor: experiment and replication. *Journal of Experimental Education* **57** (1), 5–15.

