Towards Humor Modelling and Facilitation in Smart Environments

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ABSTRACT

We know about word play, verbal jokes, and about humor that appears spontaneously in conversations. This humor is studied in computational linguistics, together with issues such as verbal incongruities, ambiguities, irony and sarcasm. These appearances of humor are also part of computational humor studies, where a broader view is taken, that is, a view that includes artificial intelligence, reasoning, common-sense and context representations, and machine learning. But there are other kinds of humor. We can laugh about events that appear in our physical world. We can play an active role in having these events happening. Obviously, they can be accompanied with verbal comments and interaction. Nowadays physical worlds are equipped with multimodal sensors and multimedia actuators. Environments do not only have human inhabitants, but also tangibles, wearables, social robots and 2D and 3D display possibilities that can help to create changes in the world that is perceived by its human inhabitants. The possibility of humor creation can be transferred from the purely linguistics worlds of text and verbal exchanges to virtual, mixed, augmented and physical reality intelligent environments equipped with sensors and actuators that can help to create and control humorous events. In this paper we introduce this research area and we survey what is available in humor research literature that may help to establish this research area. Applications of this research include avatar behavior in videogames, robot and product behavior in entertainment, social, and game environments, and in smart physical environments that allow for playful and humorous events.

Keywords: Computational Humor, Verbal Humor, Intelligent Environments, Sensors, Actuators, Physical Humor, Virtual Reality, Videogames, Avatars

INTRODUCTION

Can we have a computer that can both recognize humor and adequately respond to it? Can we expect that there will be computers that can create humor at the right time? Both require a model of humor and both require that model to be formal enough to allow us to make rules for understanding and generating humor, rules which a computer algorithm can process and which also allow taking into account the context of interpretation and generation. That is not all it takes either. To understand humor, it requires the knowledge of a certain amount of 'common sense'. What is normal, and what is different? It requires knowledge of global affairs. ("President Bush and Osama Bin Laden play a game of chess. Bush loses. Why? He had lost two towers before he'd even started.")[1] Perhaps we should just accept that modeling such knowledge, and reasoning about it, is a hopeless task. People are able to make - and understand - the most ridiculous associations. On the other hand, we have also seen that a computer, with the help of

[1] In most European languages the 'rooks' in chess-play are called 'towers'.

sheer computing power and relatively simple modeling, can beat a world chess champion or win a game like 'Jeopardy' against human opponents. However, in both of those instances, this follows decades of research into playing strategies, reasoning, learning, retrieval, forming associations, processing natural language and modeling to represent knowledge. Sadly, we have not seen a similar effort has been done on detecting or generating humour in texts or verbal exchanges. Let alone, that we have seen efforts that go into the direction of computationally detecting and generating humor in physical worlds.

Humour can be studied from either a psychological or sociological perspective. What is the importance of humour at work and in relationships? What sort of role does humour play in everyday life, in our dealings with other people and in our home and work lives? The importance of that role has become increasingly visible in recent years as our surroundings have gained sensors and actuators that know all about us and react to us. We expect our surroundings to react to us in an increasingly human way, or to at least be aware and capable of adequately anticipating and reacting to our natural human and social behaviour. Partly because of the presence of physical social robots and virtual social agents with bodies and human-like appearances, in these kinds of environments we increasingly expect there to be natural interaction between an environment and its user or users. Interactions are then based on knowledge of the environment, its events and the characteristics of the 'inhabitants' of that environment, including their behavior. Smart environments get access to knowledge that we, as humans, have access to and can use to create humorous events and fun. In other words, it becomes apparent that not only our future intelligent environments might be able to detect and perhaps even understand verbal humour interaction and non-verbal humour interaction, but we can also 'guide' an environment towards conditions which make humorous interaction possible.

The aim of this paper is to provide some insight in those aspects of humor research that can help to realize environments that are not only intelligent, but also have a sense of humor. Achieving this goal might seem far away. But probably the same could be said about the computer entering the Jeopardy game before it turned out that a concerted effort of computational linguists, artificial intelligence researchers, computer scientists, and information retrieval and machine learning experts could render a machine capable of competing with top human players. Humor needs to be computable in order to provide our intelligent environments with a sense of humor and make them cooperative in creating humor. The notion of computational humor has been introduced before (Hulstijn and Nijholt, 1996). However, most of the efforts to model humor were concerned with modelling verbal humor, in particular jokes and wordplay, e.g., (Binsted and Ritchie, 1997). Now that we can design and control our environments similar to our control of our writings, can we design humorous events just as we can design humorous texts? We can look at this question from the point of view of videogames, augmented and virtual reality environments, interactive art installations, and 'real-world' physical environments equipped with multimodal sensors and multimedia actuators that can make changes to the environment and can make events possible or happen. Obviously, unlike when we write a humorous text or tell a joke, in these virtual and physical environments we have (semi-)autonomous humanoids and human inhabitants that play an active role, that is, they interact with each other and with the environment. And clearly, asking the environment to have a sense of humor requires also that the environment is open for interactive and spontaneous humor.

In the next section we will mention some aspects of theories of humor that are relevant for our investigations here. We will elaborate on the notion of incongruity since it is not confined to texts and verbal jokes. We think that artificial environments, whether they are videogame, virtual training, or ambient intelligence environments can have the possibility to create humorous events and interactions or to help human inhabitants to create such possibilities by introducing ambiguities and incongruities in these environments. In further sections we especially focus on what has been done in research on physical humor (humor in physical environments and involving some physical activity, rather than humor appearing in text, speech or dialogue), multimodal aspects of humor and incongruities, and incongruities in products. At the end we mention why we should also pay attention to humor in videogames.

THEORIES OF HUMOR

Superiority/Disparagement, Relief, and Incongruity

There are various theories of humor, most of them address the analysis of verbal humor, in particular the analysis of

jokes. That is to say, how do we analyze and understand a joke like the "Bush..." one above? We can try to theorize about what knowledge and what reasoning is necessary to understand such a joke. But in addition, when talking about appreciation, we should also take into account emotional and cultural aspects that in some way need to be modelled too. Then it becomes clear that a generalization that goes beyond one or two examples requires a modelling of knowledge and reasoning processes so vast that that theorising will not reach an application level. However, as in the case of Jeopardy, we should be careful with such a negative conclusion. Here we mention the three main theories of humor. Rather than being competitive, they address different aspects of humor, in particular social, emotional, and cognitive aspects.

As mentioned, although not always presented as such, most of these humor theories address verbal humor. Investigations into verbal humor can certainly help to understand humor in general. Moreover, such investigations are being done from a computational point of view, a view that is embedded in computational linguistics research. We might want to learn from that when we want to expand our findings from one-dimensional language to two-dimensional drawings or three-dimensional products, humans and environments. And, in particular when we want to go from a situation where humor is consumed, to a situation where with support of the (intelligent) environment, humor is spontaneously created in interaction with the environment and its human and artificial inhabitants. This latter possibility may look overambitious, but there is no reason not to investigate it. We will return to this in the next sections.

As we said, most of the existing theories of humour apply to modeling verbal humour. These theories can be found in humor text books such as (Raskin, 2008). The first theory we want to mention is the *theory of superiority or disparagement*, which is linked to names such as Plato, Aristotle and Hobbes, assumes that we laugh at the misfortune or inferior position of others. Slipping on a banana skin is an example of that, but mostly we see it happen in jokes. For example, *"How do you make a blonde laugh on Saturday? Tell her a joke on Wednesday."* Or, *"Why do men like blonde jokes? That is because they can understand them."*

A second theory of humor is associated with Sigmund Freud and is called the *relief theory*. Freud describes humour as a necessary means to release pent up frustration originating in unpleasant experiences or social and sexual taboos (Freud, 1905). A nice example, mentioned by Freud is the following joke. *A royal personage was making a tour through his provinces and noticed a man in the crowd who bore a striking resemblance to his own exalted person. He beckoned to him and asked: "Was your mother at one time in service in the Palace?" "No, your Highness" was the reply, "but my father was."* AI expert and philosopher Marvin Minsky built on this by mentioning cognitive taboos that are breached when jokes defy logic (Minsky, 1981). For example, *"Ethel orders a pizza. The waitress asks her whether she would like it cut into four or eight slices. Ethel answers 'Just four, I'm on a diet.'"*

The third theory we should mention is the *theory of incongruity*. This is linked to names such as Schopenhauer, Kant and Bergson (Bergson, 1900). We laugh because something seems incongruous. To be more specific, we have particular expectations of how things should be or how things should go. These can be expectations based purely on common sense, or expectations that are evoked by a situation which is set up to be misinterpreted, or a text, such as the set-up of a joke, which misleads us (like the situation did). That 'misleading' aspect can of course take very many different forms, and it can be seen as a necessary condition for humor, but certainly not as a sufficient condition. Not every misunderstanding leads to a humorous situation. As mentioned, different theories focus on different aspects of humor and they can complement each other. In many humorous situations we have a victim or victims to laugh about, inappropriate things happen and incongruity is present. In the next subsection we have more observations on incongruity.

Incongruity and Incongruity Resolution

The theory of incongruity has in fact become the most influential approach to humor understanding. Refinements have been made to it to try to arrive at the above mentioned 'sufficient' conditions. This also draws on observations from the other theories mentioned above. When is incongruity funny? Does there always have to be something absurd or inappropriate? And how can we describe and define that 'inappropriate' aspect? A standard example of a joke used to illustrate the theory of incongruity is the doctor joke: "A man rings the doorbell of his doctor's house. The doctor's attractive, young wife opens the door. 'Is the doctor home?' the man whispers. 'No,' she answers, 'quick, come in.'" We can model a joke like this, in the tradition of AI scholars such as Minsky and Schank, by talking about scripts and frames that describe particular situations. The set-up of this particular joke assumes that a visit to the doctor is for a medical consult. That assumption is valid, but from the dialogue that follows we change to

a different interpretation of the situation. We have been misled and we can also say that some inappropriateness has been introduced. The incongruity is 'resolved' because we find out that we made an incorrect assumption about the situation and only now understand what was really happening. That incorrect assumption is possible because the description at the start leads us to obvious interpretation whilst not ruling out the possibility of a less obvious interpretation. And once we have the new information that follows, we notice that we should have chosen the less obvious one, we are misled. And that can make us laugh. It does take a certain amount of cognitive effort to resolve incongruity. Some researchers also talk of the incongruity-resolution theory, where it is the resolution itself that is most important rather than the resolved incongruity.

An observation that we can also identify in the literature is how being 'misled' often goes hand-in-hand with the main characters going down in our estimations. We view the doctor's wife differently when we find out that she takes lovers in off the street. And that particularly applies to the mother in this joke: *"A mother is on the phone. 'Doctor, doctor, please come right away. My baby has swallowed my fountain pen.' Doctor: 'I'm on my way. Don't panic!' Mother: 'No, no, but come quick. I really need this fountain pen.'"* There are plenty observations to be made, but you can find exceptions to each one. A more general observation that is also linked to 'sufficiency' was made by Apter, a psychologist (Apter, 1982). He introduced motivational states, including a 'paratelic state of mind', which is a state of mind inclined towards being playful (as opposed to a serious state of mind) in which one is receptive to humour. There are situations when we are expecting humour and we laugh about things that we would otherwise find threatening or sad.

It should be pointed out that the incongruity in the jokes above was constructed. It was not spontaneous. In conversations, we can react in a quick and humorous way to what our partners say or what is going on around us. This often requires us to make an unexpected association or provide an alternative explanation for something which is being said or happening. This spontaneously introduces incongruity, drawing on multiple interpretations - including absurd and inappropriate ones - of what had previously happened or been said (Nijholt, 2007). Taking 'what previously happened' into consideration, also gives the physical world a part to play. How do we perceive incongruities in the physical world and can we actively introduce incongruities, if useful supported by speech and dialogue, in our physical world? Where, of course, with our mobiles, tablets and laptops, wearables to add to our bodies, having our environments embedded with sensors, actuators and displays, and having our environments inhabited with physical or virtual agents, we have more than ever the possibility to control our environment and have more than ever the possibility to let the environment make decisions about what can happen in the environment. If the environment has a sense of humor, whether it is physical or virtual, it can decide to introduce a practical joke at the right time or it can decide to fool an inhabitant by misleading him or her and acting in an inappropriate but humorous way.

Computational Humor

There have been attempts towards automatic interpretation and generation of humor (see (Hulstijn and Nijholt, 1996; Hempelmann, 2008)). But, until now these attempts have focused on verbal humor only. This cannot be a surprise, since natural language processing, with its input from computational linguistics and artificial intelligence, is a well-established and long existing research area. Hence, before we start looking at humor that is not expressed in language only, we should have a look at computational approaches to verbal humor in the hope that are ways to generalize them to other forms of humor, that is humor that is expressed in multiple modalities, rather than in language only. However, as should be clear from the previous observations on humor theories, we have virtually no points of reference to employ when it comes to designing algorithms to analyze and generate humour in language, let alone in any other combination of sensual perception whatsoever. Yet, it can be a hindrance to traditional scholars of humor interested in a computational approach to have a multitude of different ways to approach humor to consider and have to take into account the different modalities and combinations of modalities of expression. This may become different when computational humor becomes, as we argue in this paper, included in multimodal human-computer interaction research.

When looking at the language modality only, we cannot really report success stories. Past research has produced few meaningful results. We began this article with the Bush-Bin Laden joke. The similarities between chess and war have been known ever since the time of Machiavelli. And we may also know there were towers in New York and chess also involves towers (which in contemporary English are known as rooks). We also cannot assume that everyone, let alone a computer, can automatically know the relationship between former President Bush and the late Bin Laden. Equipped with our knowledge of the world and how to reason about it, we can interpret a joke like this Affective and Pleasurable Design (2021)

in terms of AI knowledge representation formalisms such as scripts and frames. Modelling common sense and world knowledge using such schemes have been tried (Lenat, 1997) and the 'big data' approach in IBM's Jeopardy project would of course be useful here (Ferrucci et al., 2010), but rather than resolving ambiguities, humor requires playing with ambiguities, introducing an additional problem to AI and computational linguistics.

It might seem an impossible task to leave to a computer, and many AI researchers would second that view. But, nevertheless, it is possible to make steps in that direction, i.e. towards computational humour. It is of course possible to look at the generation and interpretation of jokes in a very limited context. That limited context does not have to include all knowledge of the world in order to generate or understand a humorous comment.

For example, representing the associations between words in puns can make it possible to generate new combinations of words with unexpected and sometimes amusing meanings (Binsted and Ritchie, 1997). That study concentrated on generating puns, such as: "What do you get when you cross a sheep and a kangaroo? A woolly jumper." Representing and using associations between words is of course significantly easier than using associations between world events, like we did with Bush and Bin Laden. But this pun generating program could not guarantee or determine whether a generated 'pun' was funny, that is, whether it was a pun at all. No matter how we try to combine concepts and features we cannot guarantee that it will result in something that people will find funny. Once again, we can try to formulate necessary conditions, but we cannot be sure how necessary they are. We can formulate some 'conditions' which perhaps approach being 'sufficient', but once again there is no guarantee of success. The same can be said of the approach in (Tinholt and Nijholt, 2007) where the authors intentionally try to create misunderstandings in a conversation.

It is not uncommon, in situations when we are unable to find rules, to seek salvation in machine learning techniques. That is what happened in computational humour research too. We can find a useful summary of such research in (Mihalcea, 2007). This kind of research is based on the availability of large quantities of data, especially texts available on the internet, attempting to identify patterns in such data which can be used to distinguish funny texts, paragraphs and sentences from other texts, paragraphs and sentences. We will not go into this any further, although it is possible that this kind of approach could be useful for having an IBM 'Jeopardy' to humor detection and understanding in texts.

All the approaches to computational humor that we included here are about detecting, understanding and generating verbal humour. There have of course been attempts to itemize non-verbal and visual humour, in cartoons, on-stage comedy, sitcoms, and real-life situations. There has been little or no attention for identifying these kinds of humorous situations by computer, let alone for producing these kinds of situations in a physical environment with sensors and actuators or a virtual environment such as a video game. But we may expect to see more research in this direction now that there are growing possibilities to monitor people and to adapt environments to activities of their inhabitants, whether it is in videogames, virtual reality environments or the physical world. In the next section we will look at what has been said about creating and understanding (potentially) humorous situations and events that can take place in the physical world. Obviously, the role of language should not be excluded here, but if language plays a role, then this role is clearly connected to the events that take place or can take place in the virtual, real, or augmented real world.

HUMOR BEYOND THE WORLD OF WORDS

We can use elements of language to construct humor. We can use elements of the physical world to construct humor. The construction can require some intentional preparation, but it can also happen spontaneously, taking advantage of, or triggered by interactions or events that could not have been predicted in advance. Spontaneously, naturally occurring events can be funny. Often it is better to speak of accidental humor rather than of spontaneous humor. America's Funniest Home Videos is a rich source for research on accidental humor. In these video clips language plays a secondary role or no role at all.

Hence, we can encounter and introduce incongruity in the physical world, not just in the linguistic world. It can involve linguistic interaction or linguistic commentary, but not necessarily. We can laugh watching a silent movie or

a performance by a clown or mime player. We can also laugh at how a cyclist manages to weave through traffic in a nimble, strange, perhaps even incongruous, way. Or, when we look at how someone manages to perform a task in a particularly clumsy way. Or, when we see a child that finds an unusual yet original way to overcome its physical limitations. We can learn from how humour is enacted on stage, in films and in comedy television programmes even if the linguistic humour in the dialogue frequently dominates. We must remember that, like when we listen to a joke being told, we cannot influence what goes on in the circus, on the stage, in the film or in the television programme. We are spectators, we observe and we can laugh, we are not participants and therefore we are not potential victims of the humour, we are not addressed, except perhaps in a moment like a direct confrontation with a live comedian on stage who directly speaks to us or gives us a piece of his mind. Furthermore, when it comes to theatre (Brecht) and film, some writers and directors aim for greater audience involvement than others. And, of course, there is an endless quantity of art that is made to trick us, in a confrontational way, yet also in a playful way that makes us laugh as soon as we realize we have fallen for it. 'Pulling the wool over the human perceptual system,' as Douglas Hofstadter puts it in (Seckel, 2004). (Seckel, 2004) is mainly about optical illusions; Hofstadter's point is more general and does concede that various senses, sometimes with partly incomplete and partly conflicting information, do reach a conclusion that subsequently has to be revised. So let us move on from linguistic incongruity to incongruity that involves the various senses we use to perceive the world. Incidentally, we are leaving out discussing humor in cartoons (but, see (Junco, 2008; Hempelman and Samson, 2008; Gerin, 2013)).

Incongruity and Humor in the 'Traditional' Physical World

In this subsection we will look at humor as it can appear, intentionally or accidentally, in the real world, Obviously, nowadays our physical real world is integrated with virtual worlds that we access with smart devices that not only can be used to communicate with others, but also to control the environment or communicate with the environment (domestic appliances, interactive entertainment). But, in traditional humor research, when looking at humor in the physical world, we are more interested in what kind of humor can emerge from having a banana peel on the floor than from having a robot vacuum cleaner on the floor. Traditionally this is called physical humor. It does not necessarily require language support. But of course, language can give a humorous flavor to an activity or event, for example by commenting on it and give it an unusual but not impossible interpretation. But here, we will mostly speak about incongruities in human behavior and objects in physical environments.

We can find views on physical humor from sources such as the philosopher, Bergson (Bergson, 1900). On this, he often refers to 'inelasticity' of movement or behaviour that creates comical situations because of the contrast we see between this and natural movement or behaviour. Natural versus 'mechanical', including when mechanical also means not adapting to changing surroundings and carrying on despite failing. Each of the theories of humor previously mentioned contains aspects we can also apply to potential humor in the physical world. We can see this in Morreal's attempts (Morreal, 1983) to identify humor techniques in the context of the real world. A useful distinction which he makes is the need to separate incongruity that presents itself in the world from how a person constructs and introduces incongruity. Morreal attempts to list all kinds of humor in the real world. When it comes to incongruity, he distinguishes between categories such as imperfection of people and objects or things that create humor. For example, in people these are physical imperfections, thoughtlessness and stupidity, moral flaws and failed actions. Humor can also be generated by misrepresentation of people, objects and things. For example, he mentions imitating someone, pretending to be someone else or claiming to be more important than one is in real life. Morreal identifies other categories too, such as coincidence, repetition and things out of their proper place, with the latter category, indeed, resembling incongruity in general, highlighting an aspect that already features as an element of the other categories.

A more elaborated listing of categories of humor and associated techniques is presented in Arthur Asa Berger (Berger, 1993). He distinguishes four basic categories under which his techniques of humor can be subsumed. The categories are *Language* (the humor is verbal), *Logic* (the humor is ideational), *Identity* (the humor is existential, and *Action* (the humor is physical or nonverbal). We give a few examples from (Berger, 1993) for each category. For example, for *Logic* (making comparisons): "What's the difference between capitalism and communism? In capitalism, man exploits man. In communism it's just the opposite." Or, for *Logic* (accident): Newspaper Headline: "Officer Convicted of Accepting Bride." And so there are many more techniques for introducing humor in the *Logic* category: absurdity, mistakes, repetition, rigidity, reversal, etc. For *Language* we can find techniques such as: allusion, misunderstanding, irony, ridicule, exaggeration, etc. For *Identity*: embarrassment, parody, mimicry, impersonation, caricature, etc., and for *Action*: chase, slapstick, speed, time. Chase scenes involve accidents, mistakes, coincidences, enjoyable escapes. Slapstick often involves degradation by action, physical insults, attacks

on status and importance (Berger, 1993). Unfortunately, as may be clear from this summary, there is a multitude of techniques related to *Language*, *Logic*, and *Identity*, while the *Action* category is limited to the few techniques we mentioned. Moreover, the *Action* category seems to be more related to activities on stage and in film than to what happens in real life. We already mentioned America's Funniest Home Videos as a rich source for research on accidental humor. This humor certainly belongs to the category *Action* (the humor is physical or nonverbal), and clearly it involves such aspects, mentioned by (Morreal, 1983), as thoughtlessness, stupidity and failed actions.

Incongruity can occur in someone's appearance or posture, movements, behaviour, clothes, facial expressions and so on. Incongruities can be introduced accidentally and intentionally. In the former case it can lead to funny situations, in the latter it is aimed at creating funny situations. Intentionally introducing funny situations is an obvious thing to do in a circus, in comedy on stage and in movies, and, of course, in texts. It is less appropriate to do so, apart from in our verbal interactions, in our daily activities. This is not completely true. In our interactions with children we create funny situations and display funny behavior. This is also the case in relaxed situations with our friends or with people with whom we are intimate. Objects and products can be fun too. An object can be used in way that was not intended when it was designed; an object can appear in places where it does not belong. In these cases an incongruity may be accidental or intentional, but it was not part of its design. Obviously, a product can be designed in such a way that it will have a humorous effect when it is used. Our natural environments, that is, our physical locations, contain such products. Children's toys are a good example. And so is a rubber duck that talks like Donald Duck when you squeeze it or that instead roars like a lion. This is a cross-modal incongruity in a product that has been designed to show such an incongruity (Ludden et al., 2012). Obviously, this is different from spontaneously generated humor or accidental humor. Also for this designed humor in natural physical environments, we should take into mind what Apter [1982] said about a receptive state of mind: eating shoelaces like strands of spaghetti can be hilarious too. Defying social and cultural conventions associated with a particular setting can have the same effect. This can likewise evoke illusions that do not correspond to how the world actually looks or works according to the laws of nature.

Incongruity and Humor in 'Traditional' Media

We can have verbal humor in speech, conversations and text. In the previous section we looked at humor as it can emerge accidentally or created intentionally during our daily activities in our physical world. We can also look at humor as it appears or can be created in film, sitcoms, commercials, products, comedy on stage and in performances of stand-up comedians. In these situations the audience consumes humor and although in the case of live performances there can be feedback from the audience to the performers, generally this does not really change the contents of what is conveyed to the audience. In films, circus, sitcoms and comedy on stage we see situations that are designed, that simulate real-life events or that otherwise can be recognized and accepted by the audience as being possible, even if it includes irrational decisions, unbelievable horror or magical events. In the next section we will look at digitally augmented physical environments, that is, environments equipped with interactive digital media, supported by sensors and actuators.

There are constructed worlds around already, of course. We can look at how incongruity and humor have become a part of literature, music, theatre, film and television. This is something we can learn from. We will still accept situations which are not realistic if we are able to empathize with them in some other way. People have had opinions about humor in theatre, humour in film and humor on television (i.e. humor wherever there is also or even predominantly a visual aspect) ever since theatre, film and television were invented. Greek plays have been analyzed for their use of various forms of humor (metaphor, parody, hyperbole, metatheatre etc.) and this was certainly also done to silent film (slapstick, farce, screwball etc.). However, these are not overall categories. Nor are they conditions or tools to generate or understand humor. More can be learned from the real-world humor observations of the earlier mentioned Bergson and Morreal. Obviously, in comedy and film, maybe in an exaggerated form, we have representations of real world situations. There are many books on comedy writing, for example (Byrne, 1999). Clearly, in this paper we cannot survey everything that has been written there. There is less literature on the analysis of humor in films, but interesting views on incongruity can be found in the work of the film philosopher Noël Carroll (Carroll, 1996). Carroll mentions that a 'sight gag' provokes amusement the juxtaposition of incompatible interpretations. He identifies six distinct categories of 'sight gags' in films, in each of them the directors appear to play with different interpretations. We can recognize such playing with interpretations in his opinion, from the perspectives of both the spectator (the viewer of the film) and the characters in the film. The categories that are mentioned are (1) The *mimed metaphor*, where we can see an object either literally or figuratively (Charlie Chaplin treating a boot as a meal); (2) The *switch image*, where we are presented with a view on a particular situation or

event, but when zooming in or out, or with a change of camera position we learn that we misinterpreted the initial, visually ambiguous, scene; (3) The *switch movement*, where an actor attempts to have his behavior re-interpreted (e.g., from inappropriate to appropriate) by other characters in the film; (4) The *object analog*, similar to the mimed metaphor in the sense that an object is used or treated in an unusual way, but it has similarities to an object that is meant to be used that way; again, this requires two interpretations, one is the literal one, the other is the metaphorical one; (5) The *solution gag*, maybe not completely distinct from the previous categories, where the audience enjoys the wit of the protagonist to escape from a threatening situation by behaving or using tools in incongruous ways; (6) The *mutual interference or interpenetration* of two (or more) series of events (or scenarios). As mentioned by Carroll, this latter category is the most frequent form of the sight gag. Series of events can be staged with the director's aim to produce different plausible interpretations. Creating different points of view that are plausible can be aimed at the audience, that is, they can be aimed at fooling the audience. But it can also be the case that the audience is aware and gets its enjoyment from the characters that are not aware of an interpretation of events that is available for the audience. In both cases the audience can enjoy what is happening. There are incongruities to be resolved by the audience, and there are incongruities that can be observed and enjoyed by the audience while watching the characters trying to deal with them.

Commercials and animated films often contain incongruities. Animated films are usually made to provide fun and we love to see cartoon characters subjected to incongruities or causing incongruities. These incongruities can be there, because the design of events in these films doesn't have not to follow rules of physics, biology or evolution. Hence, there are all kinds of ways we can see boundaries being broken, such as the laws of physics and biology (blocks of stone hovering in the air until the right moment to fall; whatever happens to a cartoon character, it never dies) and social norms (always resisting authority rather than accepting it). We can find amusing arguments about the laws of animated films in a June 1980 Esquire article "O'Donnell's Laws of Cartoon Motion" (reprinted in (O'Donnell, 1985)). More recently, and partly based on the work of (Berger, 1993), is the classification of humorous situations in television commercials, as presented in (Buijzen and Valkenburg, 2004). Berger listed humour techniques for verbal jokes. This more recent work expands this to humor in television commercials. The authors initially identified 41 distinct techniques that could finally be grouped into 7 humor technique categories: (1) slapstick, (2) clownesque humor, (3) surprise, (4) misunderstanding, (5) irony, (6) satire and (7) parody. The major difference between this and the earlier work by Morreal and Carroll is its systematic and statistical analysis of collected material so it can also comment on the frequencies of techniques and the preferences of age groups. It should be noted meanwhile that this refers to humour in audiovisual and other advertising material, and generalizing this to other situations requires rethinking of the categories.

Towards Incongruity Humor in Smart Environments

As has become clear of the previous sections, a lot of theory has been developed for verbal humor, drawing on ideas of how to represent and reason about knowledge of objects and events. This focuses on analyzing humor, not generating it. Virtually no research has been done into how to create events in the real world with the aim of facilitating or activating humorous activity. We can reshape and direct our verbal and non-verbal behaviour to strengthen the generation of humor. There is less scope to frame and direct the real world to create humorous situations or to make it more likely that verbal and non-verbal humor will be created. But it is not completely out of the question. For example, we can arrange a small part of the world to orchestrate a practical joke, meaning a seemingly obvious activity has unexpected consequences for its 'victim'. We can play a joke on someone by making unexpected changes in his or her world which turn ordinary acts into hilarious situations.

The question is whether creating these funny situations and initiating amusing turns of events is something we can leave to a computer or to computer-supported environments in which we immerse ourselves increasingly deeply and in which we encounter more and more artificial partners such as social robots and virtual agents with whom we will have social and friendly relationships. Clearly, we can accept humor while interacting with our artificial social agents, whether they are robots, virtual agents, digitally enhanced pets, or other devices to which we attribute human characteristics (Reeves & Nass, 1996). But we also know that interconnected digital partners are also connected to the sensors and actuators in our physical environment. And therefore we may expect that we will accept and enjoy digital humor created by artificial agents and smart environments that involve surprising changes in the appearance of the environment, surprising social behavior, and surprising changes in the usual laws of physics or biology, or the creation of perceptual illusions. Hence, assuming that our smart environments and their artificial inhabitants become real smart, we may assume that many of the techniques mentioned in previous sections on humor generation in 'traditional' physical worlds (Bergson, 1900; Morreal, 1983) and in 'traditional' media (Carroll, 1996) will find

employment in future smart environments. Display and augmented reality technology offer us, for example, the *switch image* or the *mutual interference* mentioned above by (Carroll, 1996), to intentionally confuse (and hopefully entertain) the inhabitants of the smart environment, whether the initiative is with the environment, its artificial inhabitants, or other human inhabitants. Interestingly, Bergson mentioned the humorous effect of 'mechanical' behavior, meaning behavior that poorly adapts to changing environmental conditions. This allows us another view on smartness that is displayed by a smart environment and its artificial (physical or virtual) inhabitants. We can laugh about the unintentional failures or shortcomings of the technology leading to humorous situations. Even more interestingly is the situation where the technology is aware of these failures and shortcomings and comments on it with self-deprecating humor.

Humans inhabiting such smart environments can be the 'victim' of humor generated by the environment and its artificial inhabitants, they can create potentially humorous situations using sensor and actuator technology, and they can have humorous interactions with the environment and its inhabitants, where the interactions involve sensor and actuator technology. Rather than using 'text constructs' to create humor, we now use 'digital constructs' that make an appeal to all our senses. Maybe we should emphasize the distinction between intentional humor, whether it is created by the environment, its human and artificial inhabitants, or in interaction between both, and situations or events that spontaneously occur because of misunderstandings or failures and that need a human observer who is able to understand what is going on in, for example, Jacques Tati's behavior in his 1957 movie 'Mon Oncle', where he has to deal with 'modern' kitchen technology, or Tati in his 1967 movie 'Playtime' where he is struggling with modern, technology enhanced office and city (Paris) life. Introducing new technology in a household can lead to hilarious situations, not only involving family members, but also for pets as is illustrated with many YouTube videos of kitty cats trying to communicate with a robotic vacuum cleaner. This unintentional humor can be expected and therefore be facilitated by a digitally augmented physical world. In the original view of Silber (Silber, 2013) there are more reasons why, when living in a digital media world, we will be confronted with humorous, incongruous situations. In the tradition of many other researchers in human-computer interaction he mentions humor that can arise from shortcomings of (interaction) technology, especially when these shortcomings arise from attempts to provide the interaction technology with human-like properties. But more interesting is his use of Linda Stone's notion of continuous partial attention and observations on scanning behavior, multi-tasking and being a 'life node' on the network (Stone, 2006), that can lead to 'unintentionally muddled information', 'unintended juxtapositions', 'mental mismatches', and therefore, incongruity humor.

Concluding, in our (future) smart environments we have sensors and actuators, wearables and artificial agents. Embedded intelligence can decide about the creation of potentially humorous situations. Human inhabitants can decide about employing this technology to create (potentially) humorous situations or interactions. Moreover, introducing smart and agent technology may lead to lead to humorous experiences (when in the right motivational mode (Apter, 1982)) because of failures and shortcomings in attempts to imitate human-human interaction behavior and not being able to satisfy expectations about such behavior.

Incongruity Humor in Video Games

It is useful to look at attempts to design humor in video games. Video games can be considered as a particular kind of smart environments. The gamer has to follow the rules of the game, the story line, and the interactions that are needed to satisfy the rules, the storyline, and the progress and success in the game. Usually, humor is designed as part of scripted interactions, or it is presented, for example in cut scenes, without any interaction at all. Clearly, scripted interactions can be triggered by events that happen during game playing. There is also humor that happens because a gamer can make certain (incongruous) choices about his or her appearance, movements, behavior and decisions. And there is humor because the gamer is able to find out about game playing possibilities that have not been foreseen by the designer. In addition, in on-line multi-player games there often is the possibility to use a communication channel where players or audience can have text or speech chat interactions while commenting on the progress of the game. So, video game worlds very much restrict the gamer in the interaction choices and decisions. It allows the game environment to lure the gamer into situations where he or she has to deal with humorous comments on his or her game behavior and progress (for example, in *Portal*) or where these comments are meant to distract and provoke the gamer in order to guide him or her into making wrong decisions.

Obviously, introducing humor in video games should be done very carefully. Rather than frustrating a gamer, it should motivate or challenge the player, something to fight against, provide enjoyment or be used as a weapon against opponents. Usually, but there are exceptions, gamers are not given the opportunity to introduce incongruities

during game play. Virtual reality, graphics, and interaction technology allow doing so, but it would disturb the scripted story line and current artificial intelligence does not yet allow a satisfactory adaptation of the game to such 'disturbances'. Hence, more than enough reason to experiment with game and gamer created humor in videogames and see how ideas and results can find their way in smart physical environments that don't have a storyline, but where their inhabitants making use of smart sensors and actuators, advanced interaction and display facilities, smart objects and mobile, maybe humanlike, devices, have the opportunity to create their own sequences of humorous events.

CONCLUSIONS

The main argument we have put forward is that the use of sensors and actuators in physical environments, the use of wearables, and having artificial partners inhabiting our physical and virtual environments, we have the possibility to digitally design opportunities in our worlds to create humorous situations, or to facilitate human creation of physical humor in these worlds, almost as if we can create humor in texts, conversations or in comedy. Clearly, the main distinguishing aspect is the active role the human inhabitants of these environments can play. They are not necessarily passive consumers of humor, but through their interaction behavior and their use of the digital media they can not only consume humor, including unintended humor, but also support and guide humor creation in interaction with the incongruity-sensitive environment.

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