Towards an Interactive System Facilitating Therapeutic Narrative Elicitation in Autism

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ABSTRACT

By telling stories to ourselves and others we make sense of the world; not only of events and why they happened, but also of the actions and motivations of ourselves and others. However, people with autism appear to live in a less coherent world; autism is a lifelong pervasive developmental disorder affecting social ability. Experiments have shown that children with autism have specific difficulties with narrative; they are less likely to take into account their audience and references to causality and affect may be missing or be inappropriate. Our hypothesis is that narrative structure itself is fundamental to the perception, creation and communication of meaning in social interaction.

We propose a software system which allows exploration of the abilities of autistic subjects to build coherent narratives from discrete stimuli such as events in pictures or photographs. Our long term goal is to identify aspects of narrative where therapeutic intervention for autistic users could be applied. In this paper we describe a pilot study and results of the first experimental trials.

Keywords

Autism, narrative, storytelling, interactive software.

1. INTRODUCTION

1.1 The importance of narrative in the creation of coherence.

The importance of narrative to the human condition is widely acknowledged by authors from many disciplines. The following examples are illustrative: “The human being is a story telling machine. The self is a story.”(Broks); “By telling stories to ourselves and others we make sense of our lives” (Linde); “Narrative is one of the most important ways in which we make sense of the world. It allows us to structure and remember events, structure time, and fit new events into a pattern.”(Schank); “It is a way to domesticate human error and surprise” (Bruner 2002); “Narrative is the principal way we organize our understanding of time” (Porter Abbott).

It is postulated that by fitting events into a narrative pattern and telling stories to ourselves and others we construct and inhabit a meaningful and consistent world (Schank, Bruner, Linde). We are able to understand the behaviours of others (people or other agents which we imbue with intent) in the context of imputed motivations and emotions, and we are able to respond in ways seen as meaningful and consistent. Our hypothesis is that narrative structure itself is fundamental to the perception, creation and communication of meaning in social interaction (Bruner & Feldman; Dautenhahn 2002), and thus narrative structure itself guides our attention, interpretation and understanding.

1.2 Narrative and Autism.

Some people with autism comment on the difficulty of finding *meaning*[1] in the world, for example, "Reality to an autistic person is a confusing, interacting mass of events, people, places, sounds and sights. There seems to be no clear boundaries, order or meaning to anything. A large part of my life is spent just trying to work out the pattern behind everything" (NAS). Autism is a lifelong pervasive developmental disorder affecting social ability. People with autism who do live successfully in the, to them bizarre, world of so-called normal people do so at least in part by learning rules: if someone smiles at you, you should smile back; note that even this apparently simple rule does not always apply.

Experiments have shown that children with autism have some specific difficulties with narrative: they are less likely to take account of their audience; and references to causality and affect may be missing or be inappropriate (Tager-Flushberg & Sullivan; Capps et al). Abell *et al* showed, using animated triangles, that children with autism were more likely to attribute inappropriate mental states than typically developing children or those with general intellectual impairment (Abell *et al*). This impairment in mentalising is often attributed to a deficit in a theory of mind. Alternatively, we may view narrative ability as causal rather than symptomatic (Bruner & Feldman; Dautenhahn 2002).

Our long term goal is to design an interactive software system which allows exploration of the abilities of autistic subjects to build coherent narratives from discrete stimuli, such as events in pictures or photographs, in order to identify aspects of narrative amenable to therapeutic intervention. In this paper we report on a pilot study concerned with recognizing and completing picture narratives.

1.3 Aspects of Narrative

Nehaniv describes three ways in which agents, human or otherwise, can relate to narrative: they can *have* a narrative, that is have an internal representation of a narrative; they can *express* a narrative, that is in some way be a storyteller; and they can *recognize* a narrative, that is in some way be a storylistener (Nehaniv 1999b). In general the storylistener has no direct access to the internal structure held by the storyteller, they only have access to it as rendered in the expression of the narrative. The storylistener must recognize the narrative and construct its own internal representation of the narrative as expressed by the storyteller. In this paper we use the word *story* to mean the internal representation, comprising at its simplest one or more events, but including interpretation, for example interpretation of causality or of the motives of any protagonists. We use *exposition* to mean the narrative as expressed by the agent. In

[1] We do not imply that there is no meaning to the lives of people with autism, but that socially constructed meaning is difficult. The more socially constructed the meaning, the greater the difficulty.

human terms there are always *gaps* in the exposition, the storylistener must fill the gaps to build their own coherent internal version of the story. Being able to fill gaps, possibly from more general scripts, is an integral part of story listening (Schank) and is crucial to understanding picture narratives, as in comics. (McCloud).

2. BACKGROUND

In this section we briefly review some relevant previous work in the domains of narrative elicitation, narrative interfaces, and work with children with autism.

2.1 Narrative elicitation.

We note that narrative ability is not the same as literacy; narrative does not depend on reading or writing, it may be in the oral tradition or be non-verbal (Bruner). Montemayor and Druin elicit narratives from children in pediatric rehabilitation by using toy-like robots as intermediary storytellers (Montemayor *et al*). It is crucial to their approach that the children are involved in the design of the robots. Aylett discusses the use of agents to elicit emergent narratives in the context of personal and social education issues such as bullying (Aylett). Cassell explores a suite of technologies for story listening systems for playful narrative elicitation in normally developing children (Cassell). Marshall *et al* describe a playful virtual environment in which the child can act in the various roles of audience, actor, scriptwriter and editor, and in particular can vary the status and attitudes of the protagonists (Marshall *et al*).

2.2 Narrative interfaces.

Nehaniv stresses the importance, in the general case, of narrative integrity in the behavior of a robot, agent, or interactive interface (Nehaniv 1999a). That is, the coherent world built by the person interacting with the system should not be needlessly shattered. In teaching social and narrative skills to children with autism it is especially important that the *interface* should be designed in a socially responsible way.

2.3 Work with children with autism.

It is widely recognized that most children with autism enjoy playing with computers, this may be due in part to the predictability of computers, and the control the children have (Murray). Over the last few years there has been growing interest in the use of interactive software and robotic systems by children with autism, particularly in a social context, for example the Aurora project explores the use of social robots with children with autism (Aurora). Dautenhahn discusses the role of interactive environments in autism therapy, and summarises the results of trials with a particular mobile robot (Dautenhahn 2004). Robins used a small humanoid doll-like robot in a longitudinal study to encourage imitation and social interaction skills (Robins 2004)**.** Pino has compared social skills elicited by normal and software versions of a game of noughts and crosses (Pino). Such interactive social systems might of themselves be effective in narrative elicitation.

3. CHARACTERISTICS OF THE USER GROUP

Currently autism is behaviourally defined and is characterized by a so-called triad of impairments, these being impairments in social interaction, social communication and imagination. In addition, repetitive behaviour patterns and resistance to change in routine are common (NAS). People with autism form a very diverse group, nevertheless there are some characteristics common in autistic subjects relevant to the design of software and experimental method.

People with autism are likely to prefer predictable, structured and controlled procedures and environments and, possibly consequently, they like inanimate objects, machines and computers.

* Experiments show that children with autism have a tendency to focus on particular details, that is, they tend to employ local rather than global integration (Happé). Consequently a child with autism might focus exclusively on some seemingly irrelevant detail e.g. great interest might be taken in the experimenter's spectacles, or a program used not for its primary purpose, but for the pleasure of the accompanying noises.
* There might be little apparent understanding of joint attention or of a shared point of reference, so, for example an interface designer should not *rely* on a child with autism understanding a reference made to an object by pointing at it. However, Robins has shown that such behaviour can be *elicited* from some autistic subjects through the medium of social robotics (Robins).
* Children with autism might have good rote memory and be able to remember the details of events; however there might be no evidence that meaning is understood. Millward showed that children with autism were able to remember what happened to other people more readily that what happened to themselves (Millward *et al*).
* Children may have difficulty abstracting from experience, for example while they might perform well on social reasoning tasks they fail to apply their social reasoning in daily life (Klin). This has implications for the design of experiments to establish the usefulness of any software.
* They might be hyper- or hypo-sensitive to perceptual stimuli, for example, finding intolerable a noise which is barely perceptible or unremarkable to others, such as a distant train or someone singing (Bogdashina).
* They might have obsessive, narrowly defined particular interests or engage in prolonged, seemingly meaningless, repetitive behaviour, this latter trait causes some concern over the use of computers with autistic subjects at all.
* They might have little or no productive language, poor communication skills and possibly have learning disabilities. Thus frequently used methods for requirements elicitation and design such as focus groups, collaborative design, questionnaires etc. might not be possible with this user group. Similarly questionnaires or discussion groups might not be appropriate evaluation techniques.

Thus it is important to include input from professionals such as teachers and therapists. Unlike software for normally developing children trying to keep attention and design out boredom is not an aim, rather we need a focused, predictable system which gradually challenges the narrative ability of the user. Consequently the rewards from the system should be the enjoyment of the experience together with targeted re-enforcers; extraneous noises or animations should be omitted. The interface should be tailorable so that that likes, dislikes, sensory sensitivities can be catered for, and adaptive, responding to the needs of the individual. The system, while in some sense capitalizing on desire for repetition, should be designed to avoid meaningless repetition. Methods for design and evaluation used with typically developing children might not be appropriate; it is necessary to keep a record of the sessions, e.g. by videotape, for evaluation purposes.

4. A NARRATIVE REFERENCE MODEL

It is widely commented that views on what is and is not narrative vary; a narrative need not end, consider soap operas; need not be pre-scripted, consider emergent narrative; need not be a sequence of events, it may be, for example, spatially oriented; need not be presented in the past tense, etc. We postulate that these are in some dimension unusual forms of narrative; they are the dachshunds and the beddlington terriers, where we are interested in the basic concept of dog. We take as our reference the transactional format proposed by Bruner for a story worth telling (Bruner, Dautenhahn) which supposes a sequence of events involving purposeful characters, and comprising a steady state, followed by some precipitating event, the restoration of a steady state and finally some terminating coda. The *steady state* establishes a world view, we include establishing the genre, that is how the events of the narrative should be interpreted, and what is permissible in the narrative; is this a narrative in which animals or even steam engines routinely talk to the great surprise of no-one? Is it a story about a princess whom we want to see happily settled with a prince? The *precipitating event* is some break in the steady state, it is unexpected by the protagonists, not necessarily by the audience. In the *restoration* the precipitating event is resolved and a steady state restored. The *coda* signals that the narrative is at an end. This sequence is a skeleton on which variations occur; a stage (such as establishing the steady state) may be vestigial, established with the briefest of reference, or non-existent, merely assumed. Alternatively a stage may repeat, this is especially found in narratives for very young children, or one narrative may be nested inside another. In our basic reference model the chronology of the exposition follows that of the story, we are not concerned with more complex expositional devices.

In order to explore narrative recognition skills we propose new finer characterisation of the notion of sequence, intended to identify the important aspects of proto-narrative. The ideas are presented in terms of narratives in which expression is by means of pictures. We identify three components; a *sequence*, *characters*, and *background* or setting. Characters can range from fully iconic simple shapes as in the work of Abell, through to fully realistic characters. Similarly the background can be a simple monotone through to fully realistic. The complexity of the background and characters can be independently varied. McCloud discusses, for example, the implications of a simple iconic character on a realistic background (McCloud). The final dimension is the sequence, we give examples in increasing complexity;

- an atemporal sequence such as three pictures of a circle each one larger than the previous one.
- a temporal, non-reversible, sequence such as pictures of a baby, a toddler and a child.
- a sequence involving causality such as an object falling on the floor and breaking.
- A sequence involving motivations of volitional agents, such as a cat moving to its own bowl and eating its own food.

- A sequence involving an unexpected happening such as a cat jumping onto the table and eating its owner's food
- Sequences involving more than one character each with motivations and emotions.

This final sequence type can be greatly expanded, by consideration of who knows what about whom and mental state attribution among the characters, but in this we are moving away from simple narrative and proto-narrative.

5. THE FIRST PROTOTYPE AND STUDY

The first prototype is concerned with narrative recognition and construction. Recalling that filling gaps is crucial in interpreting a narrative and building an internal representation, the prototype was a simple fill-the-gap narrative game using pictures. The aim of the first pilot study was to explore whether this task was appropriate for children with autism, and in particular whether they found the task as presented on a touch sensitive screen engaging and enjoyable, and indeed whether they could manipulate the screen at all. Our hypothesis was that children with autism would be at least as engaged and successful where the medium of exploitation was a touch sensitive screen as they were with a physical game.

5.1 Prior visits to schools

Two schools took part in the study; the design of the interface and choice of narratives were informed by visits to both schools. The visits allowed discussion with professionals, a chance to look at and participate in the children's work and activities, and contact with the children both at playtime and in class, in particular the visit to one school was arranged to include with a practical class using the school's computers.

5.2 Choosing the stories

Creating engaging narratives for children is not trivial. Therefore it was decided to use published sources in this first trial, in this way it was possible to be assured that the narratives used were well regarded by educators of young children, and it was possible to discuss the suitability of the chosen sources with professionals in daily contact with the children. The chosen narratives conformed to the basic transactional format of the narrative reference model, using close-to-realistic paintings, but in which, for example the facial expressions of the protagonists were simplified.

Picture books for young children typically involve a great deal of repetition, thus it is possible to extract a narrative conforming to the narrative format, from a longer work.

5.3 The physical and computer-presented games

The game was made using laminated cards, and replicated as a computer game called TouchStory (shown below), which can be presented using a touch sensitive screen. The game is to complete the narrative by moving the correct picture into the gap. TouchStory was available in two versions, in one the pictures could be dragged, and in the other, in case of a lack of dexterity, the pictures were just buttons. In fact the buttons version was never used.

All the pictures on a screen were by the same artist to avoid very obvious matching on style, palette etc. If the correct card is moved into the target position then this is accepted as a correct answer. The reward for a correct answer is simply that the distracters (alternative answers) disappear, leaving just the complete story.

Figure 1: Illustrating TouchStory in use.

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5.4 The trials

In total the subjects were 18 children of primary school age from 2 schools in England. For the purpose of the trial, each school was visited once. From the first school there were eight children, six of whom had a diagnosis of autism; the other two children had moderate learning difficulties. Ten children participated from the second school, of whom seven had a diagnosis of autism and the eighth had characteristics ‘suggestive of’ autism. The diagnoses for the other two children were complex language disorder and general developmental delay. The children without diagnoses of autism were included in the study, not as any form of control group, but for any insights we could gain. The trials were to evaluate the software and touch screen, not to assess the children.

The detailed ages of children from the first school are not known, at the second school the ages ranged from 4 ; 10 years to 9 ; 08 years. In total there were 13 boys and 5 girls, of whom 12 boys and 2 girls had diagnoses of autism.

The children were seen individually, in both cases in a small dedicated room. The sessions were videoed, one camera being trained on the child’s face, the other on the game in progress. The layout of the rooms did mean that camera angles were not ideal. The child was told that they were being asked to help in the design of some interactive software. They were then invited to try four narratives with the laminated cards. It was not envisaged that the child should play either version of the game alone, and so it was seen as a collaborative task. The experimenter gave the child feedback and if a wrong picture was chosen the child was invited to have another go. The children were then invited to play with TouchStory, the four stories which they had already seen were repeated followed by a fifth, previously unseen, story.

5.5 Initial results

5.5.1 Initial Observations

In making our observations we are making a preliminary evaluation of the usefulness of the task, the interface and the touch screen medium. There was a wide range of response to the activity, with both ceiling and floor effects. There was a ceiling effect with 6 subjects, including 3 of the four children having diagnoses other than autism (the fourth child without autism was close to completely successful). Two children did not appear to understand the task; that is to say that in both versions of the game they did not appear to understand the task of putting a picture into a space. One of these children showed great interest in the pictures themselves, and gave some description of what was in them. While being very cautious of attributing cause to behaviours, especially with autistic subjects, these two children both appeared relaxed and followed other instructions readily, therefore we believe that they did not understand the task. A third child demonstrated little understanding of the task, on two occasions he placed a picture in the space in the physical game, but on both occasions it was not the right card. Using TouchStory he dragged cards around apparently randomly.

Sixteen of the children were able to drag pictures after a short demonstration lasting about 5 seconds, the other two children could drag after the experimenter demonstrated by guiding child's own finger. The draggable pictures do not follow a finger as well as they follow a mouse, this is attributed to larger contact area the finger makes with the screen. However the children all coped, and would return to the picture if it failed to follow the finger.

Most children (all but 1) seemed to enjoy both versions of the game, all enjoyed the screen version more so. By enjoy we mean that the children appeared relaxed, actively participated, for example standing up to more easily place the cards or access the screen, and some children made appreciative comments such as 'Wow'.

TouchStory made many fewer demands on the experimenter, in part because there were fewer tasks, the experimenter did not to keep track of, or layout the cards, and also because TouchStory presented the children with fewer interesting diversions, such as 'helping' to layout the cards, or piling them up on the floor. The TouchStory games were completed more quickly than the laminated cards games.

The simple on-screen reward was adequate over all 5 games, the children remained engaged with obvious no signs of boredom. There was very little repetitive behaviour.

5.5.2 Initial quantitative measures

Of the initial 18 subject 6 were wholly correct in their answers, 3 did not make any correct answers, and 1 did not want to play, and for 1 subject there was a problem with the video camera, leaving 7 subjects all of whom had diagnoses of or suggestive of autism. Thus we have a small number of subjects and a small number of narratives. The results are presented below, recall that there are 4 narrative in the physical game and five in TouchStory; for each child the first two columns show the percentage of answers correct at the first attempt for the card game and TouchStory respectively, the third and fourth columns show the responses after the children had been invited to have another go if their first answer was incorrect.

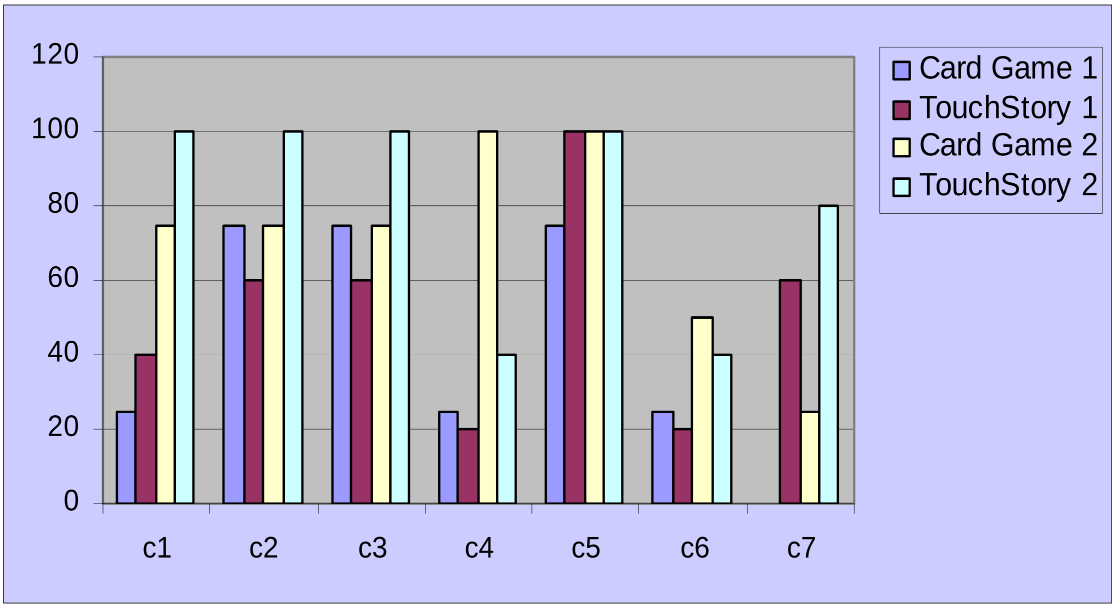

Figure 2: Comparing responses to the card game and TouchStory

6. Discussion

TouchStory, without doubt, made fewer demands on the experimenter, freeing the experimenter to observe the child's interaction. The very simple interactive interface seemed adequate, as did the reward, some of the children made comments which indicated an understanding that the reward indicated a correct response.

Some children spontaneously talked about or told the stories, and in these cases it seemed clear that their success was based on some understanding. Also it seems reasonable to suppose that the children who were wholly successful in the task had some understanding. For other children, especially those with little productive language, we could not tell whether success, or failure, was do to understanding, chance, or some matching heuristic that the child was using. Taken in conjunction with the floor and ceiling effects this points the need a greater number of narratives, including simpler proto-narratives and tighter control of the distracters.

There does not appear to be a significant difference between the children's narrative ability with the laminated cards and with TouchStory; and we would certainly not expect any significant improvement. A significant improvement in narrative ability over a period of ten minutes or so, brought about solely by a change in medium would indeed be astonishing. Overall the children were at least as successful using TouchStory as they were with the physical game. This is encouraging for our further work into narrative systems for children with autism. We hope over the summer of 2004 to develop a system presenting proto-narratives; we aim to make the system adaptive so that for each child the focus is on re-enforcing and challenging their narrative ability. We plan to trial this using a longitudinal study in the autumn term of 2004.

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