Applied virtual environments to support learning of social interaction skills in users with Asperger's Syndrome

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Abstract

Asperger's Syndrome (AS) is an autistic spectrum disorder characterised by normal to high IQ but with marked impairment in social skills. Successful social skills training appears to be best achieved either in situ or in role-play situations where users can explore different outcomes resulting from their social behaviour. Single user virtual environments (SVEs) provide an opportunity for users with AS to learn social interaction skills in a safe environment which they can visit as many times as they like. The use of game-like tasks can provide an incentive and can also be used to guide the user through progressive learning stages. Collaborative virtual environments (CVEs) allow several users to interact simultaneously within the virtual environment, each taking different perspectives or role-play characters. Within the AS interactive project a series of SVEs and CVEs have been developed in collaboration with users and professional groups with an overall aim of supporting social skills learning. Initial evaluation studies have been carried out which have been used to both inform and refine the design of these virtual environments (VEs) as well as giving an insight into the understanding and interpretation of these technologies by users with AS.

Keywords: Asperger's Syndrome, collaborative virtual environments, social skills learning, virtual environments

1. Introduction

Asperger's Syndrome (AS) falls at the high functioning end of the autistic spectrum and is characterised by average or above average intelligence, obsessive interests in specific topics and adherence to routines. There may also be marked deficiencies in social skills, non-verbal communication, abstract thought processes, theory of mind, executive functioning abilities, and imaginative play. Individuals with AS experience inherent difficulties in interaction with their peers, despite an often strong desire to do so. Due to poor abilities in recognising and interpreting social cues such as turn-taking and difficulties in non-verbal communication, they often display behaviour that is generally considered to be socially and/or emotionally inappropriate (Frith 1989). For example, interrupting conversations, talking at length about a specific subject irrespective of either the relevance to the situation or the response of the listener, or pointing out factually correct but socially inappropriate information. Individuals with AS tend to have a restricted range of interests to the exclusion of other activities. This can result in detailed knowledge of specific subjects but very limited awareness of others. There is often repetitive adherence to procedures and routines, some of which may be compulsive (Baron-Cohen and Bolton 1993).

For example, an individual may become distressed if they have a specific routine they follow which is then interrupted or changed. Social skills tend to be learnt by rote and there is limited evidence of sustained generalisation of understanding or behaviour between learned and novel situations/environments (e.g. Pollard 1998). People with autistic spectrum disorders (ASDs) are often impaired in understanding how other people's mental states influence how they behave and what they say (e.g. Baron-Cohen, Leslie and Frith 1985). This can translate into a difficulty in understanding social situations because behaviour and language can seem confusing and unpredictable. This produces a limited understanding of social norms and expectations, particularly in novel situations. A tendency to interpret speech literally (Mitchell, Saltmarsh and Russell 1997) can lead to misinterpretations of implied meaning of others and usage of formal pedantic language which may be socially inappropriate. For example, an ironic or sarcastic comment may be taken literally, without any meaning gleaned from the prosody used in its delivery; or an individual may interpret metaphorical statements in a literal sense. A statement such as, "you must be quiet, you're shouting the house down", becomes very confusing for the individual.

As a result, individuals with AS may experience social exclusion from their peers due to difficulties in making and sustaining friendships. Adults often find it very difficult to obtain and maintain employment; even though they may be capable of performing their work duties and may have specialised knowledge of their subject area. Problems with communicating their ideas to, and socially interacting with, others in the work place can produce very difficult working relationships (Howlin 1997). Specific problems encountered include difficulties with interviews, social interactions within teams, group work and interacting with others during unstructured, social time such as breaks

and lunchtimes. For example, Klin and Volkmar argue that mastering specific job demands is only part of the challenge facing people with ASDs in work situations.

Equal attention should be paid to the social demands defined by the nature of the job, including what to do during meal breaks, contact with the public or co-workers, or any other unstructured activity requiring social adjustment or improvisation.
(Klin and Volkmar 2000 361)

Moreover, they argue that

Unless issues of social presentation are adequately addressed, including what to do in specific situations such as lunch or free-time periods, the chances for vocational satisfaction are lessened.
(Klin and Volkmar 2000 351)

The *AS Interactive* project aims to address some of these issues by constructing social scenarios within virtual environments (VEs), which can be used to learn about and demonstrate social interaction skills in different situations. The perceived advantages of using VEs for this purpose are two-fold. Firstly, VE technology allows construction of realistic 3D representations of real world environments which can be interacted with and explored in real time. This means that we can create interactive contexts representing a range of social scenarios in which AS users can practise social skills. Furthermore, we can control the parameters within the environment (e.g. number of people, cues within the environment, number of solutions to a given problem, etc.). This allows us to control the number of available options and therefore the decisions that need to be made by the user. Thus it is possible to produce different levels for each scenario, involving simple choices to more complex decisions concerning behaviour initiations and responses. Secondly, the use of computer technology may be specifically advantageous to the AS community; virtual environments offer a secure environment in which they can learn rules of social interaction without having to deal

with others face-to-face. Users can also practice in the same environment over and over again without pressure or concern for how their behaviour is received by others. This provides the potential for repeated learning but also for 'learning by mistakes'. Users can examine alternative outcomes and can move progressively through levels.

Of course, whilst the possibilities for use of this technology may seem attractive, there are many unknowns to this research. For example: what social skills can be supported by this technology?, how do we present these in virtual environments?, how important is it that we replicate real situations in virtual environments and how 'realistic' do these need to be?, how do we know that users will understand and interpret these VEs as we expect them to?, and how can we support learning of skills that can be generalised and applied in the real world?

The *AS Interactive* project is a three-year project funded by the Shirley Foundation to develop single user (SVE) and collaborative (CVE) virtual environments for adolescents and adults with AS to learn social skills relevant to social interaction in public situations, particularly work-based situations. The project has two distinct phases of research. The initial focus has been concerned with feasibility investigation of the use of virtual environment technology for social skills training and establishing the involvement of training professionals and users in the design and review process. At the end of this phase we have constructed an SVE and CVE where social

individuals with Asperger's Syndrome may experience social exclusion from their peers due to difficulties in making and sustaining friendships …

scenarios may be experienced in a café. Examples of these VEs are given in the context of design decisions and user evaluations of interface usability.

The *AS Interactive* project comprises a multi-disciplinary research team with expertise in autism, computer science, psychology, and human factors of computer interface design, together with practitioners working in AS training (Beardon, Parsons and Neale 2001). An integrated research approach has been adopted which allows specification for VE design to be informed by user needs and requirements whilst taking into account characteristics and limitations of VE technology (Cobb, Kerr and Glover 2001). An iterative development process has been established which allows further design developments to be informed by user review and professional evaluations of the system (Neale 2001a). The advantage of this approach is that the combined input from these diverse disciplines allows us to consider our research questions from different perspectives and to apply a variety of methods to our review process. Hopefully, this will aid the development of a useful and usable end result.

Following initial consultation and discussions between these groups, the social interaction skills we aim to examine in the *AS Interactive* project are: appropriate use of personal space; choosing and using appropriate responses for both behaviour and communication; and dealing with unexpected situations or changes to routine.

2. Virtual environment development

2.1 User involvement in the design process

An important aspect of the project is the involvement of users in the design and review of technology development. In previous studies the authors have found that the involvement of teachers and students in technology development helps to create a sense of ownership and empowerment (Meakin et al. 1998), which has a substantial influence on usability of the interface design (Brown et al. 1999), and subsequent acceptance and implementation within the existing teaching programme (Benford et al. 2000). However, the process of involving users in learning technology design is not straightforward; each group of 'users' (i.e. teachers, students, training professionals, parents) has different objectives and can inform the design process in different ways. Moreover, the involvement of users with special educational needs requires the use of a variety of methods to elicit their opinions (many of which will need to be adapted specifically) and flexibility to ensure that their involvement is practical, enjoyable and fruitful (Neale, Cobb and Wilson 2001).

On the basis of this previous experience, it was decided that the user groups involved in the *AS Interactive* project should be involved at different stages of design: training professionals should help to define the social skills we are aiming to support in the virtual environment; teachers could then help with specification of the context for presentation of tasks in the VE and in defining specific learning objectives supporting development of the social skills in question; users themselves can help to design the content and appearance of the VE and can provide input to the design of the interface (Neale 2001a). A range of user and professional groups are actively involved in the *AS Interactive* project.

- Adults with AS drawn from three established Social Groups based in Sheffield, Nottingham and Leicester are engaged in the review of VE design and usability to help inform design specification for VE development.
- AS training professionals also attend these sessions to facilitate users in using the system and to provide feedback to the design team.
- Students aged 16–19 with ASDs, and matched non-ASD students, drawn from a range of schools in Nottinghamshire participate in formal experimental studies to evaluate the suitability and usefulness of the VEs for social skills training, particularly for this age group of students who are in the transition period from school, hopefully seeking to find employment.
- Teachers at these schools have been invited to participate in discussion workshops to review content and presentation of tasks within the VEs.

At this stage of the project we have completed the first full cycle of our design-review process (Cobb, Kerr and Glover 2001). Professionals from autism support organisations have examined existing VEs to assess the suitability of this technology for people with AS and advised changes to the appearance of the VE and presentation of information within it before it was presented to users with AS. Representative user groups then evaluated the existing VEs (with modifications as suggested by the professional group). The outcomes from these studies, combined with relevant information from the background literature reviews, were used to derive guidelines for VE design. Guidelines were defined, providing recommendations for: content of a learning environment to support social skills development, facilitation of learning styles, content and interactions suitable for users with AS, design for usability, making use of VE attributes and VE implementation (Neale 2001b).

A workshop was held with a group of 30 teachers from a school for children with ASDs who brainstormed ideas for suitable application areas, strategies for effective presentation of tasks, and possible barriers to implementation. These confirmed the view that we should place

our training scenarios within the context of generic situations familiar to everyone.

The first scenario selected for development aimed to support AS users in learning and making decisions about making appropriate versus inappropriate responses and was placed in the context of a generic café. This context was chosen because it was considered to be familiar to most people such that they would recognise what activities they could be expected to perform in this environment. The scenario was developed in both SVEs and CVEs in order to allow us to assess the interface and usability of each type of environment and to begin to consider how each could be used to support social skills learning. It was considered that the SVE would provide structured training with limited choices for appropriate/inappropriate responses available, whereas the CVE would represent an unstructured situation in which the user is free to make their own choices as to how they interact with others.

2.2 Single user virtual environments: the '*AS Café*'

The first SVE developed was referred to as the *AS Café* and is described in this section. One of the first objectives of the VE design process was to develop a suitable user interface. In the case

Figure 1.
Single user
environment
interface.

of the SVE, this required the consideration of metaphors for real world actions and behaviours. For example, how does the user indicate that they wish to sit down on a virtual chair and stand up again? How do they know when another character within the virtual environment is talking to them and how do they indicate who they want to talk to? How do they conduct a conversation in a single user virtual environment?

A number of design challenges were faced when building the *AS Café*, as it was not clear how social situations should be represented in SVEs. Some aspects of social interaction may be represented using this technology; whole body position and navigation, for example. Other social cues, such as complex verbal interaction, are less easy to represent in an SVE. We wanted the user to be able to verbally interact, by asking questions and making socially appropriate decisions as to when to ask the question, what to ask, and who to ask it to. It was therefore necessary to design an interface to support this.

A 'hybrid' VE interface design was applied (Eastgate 2001) in which the 3D VE was overlaid with a 2D multimedia interface. Figure 1 shows the single user interface design. The screen is split into two main areas, the window onto the virtual world and the interface.

The interface consists of a speech bubble (on the right) for asking questions, a text feedback with speaker icon (centre) for communication with the user, and an icon to hear the overall task (left).

The user begins their experience in the SVE by holding a tray of food at the counter and is then asked to find somewhere to sit. There are no empty tables within the café and so the user needs to find a table that has some empty chairs or spaces. The VE is designed in a flexible manner, so that the user may take a number of different paths in order to find somewhere to sit and that each time a person

uses the environment they may experience it differently.

Users may move towards a table and if there is a spare seat at it, their viewpoint is rotated towards the people at the table and they are asked what they should do next. Users then have to respond in one of three ways; they can select the table or chairs to sit down, they can select the speech bubble icon to ask a question, or they can just walk away. If they sit down without asking the other 'people' at the table, then they will be told that the seat is taken and they should then select the floor to stand up again. If the user selects the 'ask question' icon, a dialogue box then appears with a larger version of the speech bubble on it. Contained within this are questions that the user can ask (see Figure 2), these being either relevant or irrelevant to the task, with responses to the latter prompting the user to try again. The questions are set out on 'radio' buttons, which means only one can be selected, and when the user exits the dialogue box, code will register which question was asked, play the sound file and then activate the appropriate response. If an appropriate question is asked, the user will be told whether the seat is available or not and this depends on a number of factors, including whether it was the first time they had asked a question or if they had previously found out the availability of the seat. If it is the first time the user has asked a question, then they will automatically be told that the seat is unavailable. This is so the need to ask a question is highlighted to the user. Once a spare seat has been found the user then selects the table or chairs to sit down, the tray of food appearing on the table.

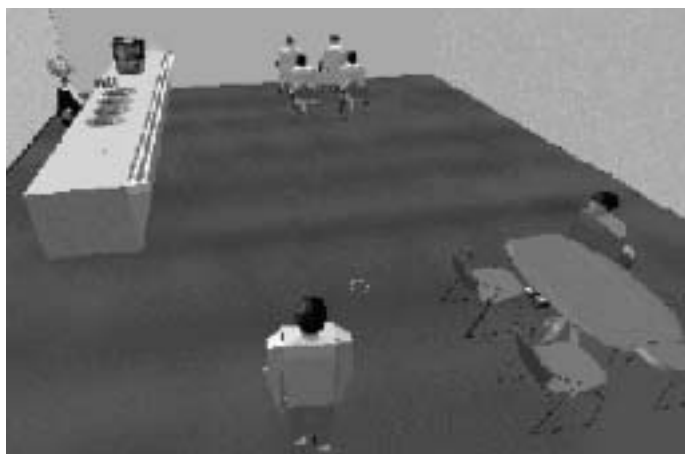### 2.3 Collaborative virtual environments: the '*Social Café*'

A CVE of a café environment, referred to as the *Social Café*, was also developed. This was intended to be a replication of the SVE *AS Café* so that the two systems might be compared in terms of how they can best be used to support

Figure 2. Choosing what question to ask.

social skills learning. The main difference between the two systems, of course, is that a CVE allows participants to communicate directly with other users in a shared virtual space, whereas in the SVE the user interacts with autonomous avatars. The implications of this for the project are that in the SVE the options for communication input and responses from others must be pre-defined and programmed into the system. This obviously restricts the number of options available whereas in the CVE the user and other characters can interact and communicate freely, providing an unlimited choice of options.

The appearance of the *Social Café* is based on the *AS Café*, although direct communication with other avatars eliminated the need to overlay the 2D communication interface (see Figure 3). The interface is mouse driven and allows the participant to navigate the environment, move or pick up objects and invoke certain behaviours. The user can enter the café building via opening the doors, navigate around the café and select items from within it. After the user has selected their desired items, they may place a selection of them onto a tray, carry them around, and find a suitable table at which to sit. The user is then free to manipulate these objects individually if desired and stand up

Figure 3. The collaborative virtual environment cafe.

within virtual environments, more exaggerated representations allow more widespread indications of who is talking at a given moment. This is achieved in the *Social Café* by denoting who is speaking by the display of 'rings' around the head of the speaker. This may then be coupled with other attributes, such as gaze direction, to better determine who is the subject of the communication.

3. Evaluation of virtual environment design and acceptability

3.1 Design, usability and acceptability

The SVE *AS Café* has been through a process of formative evaluations which have been used to refine its design and the further development of additional training modules. Adults and adolescents with AS, all members of a 'social group' were observed using the SVE with their group facilitator and were interviewed about this experience. The main aim of this evaluation was to examine the usability and acceptability of the interface design. Users were asked to follow the on-screen instructions which initially prompted them to find a place to sit down. Their on-screen actions, as well as any communication between them and their group facilitator, were recorded and analysed to examine which tasks the user could carry out and which ones they had difficulties or required support with.

Most of the tasks were carried out correctly, on the first attempt, with little support from the facilitator although it was found that some tasks within the VE were more difficult to carry out than others. These included sitting at the table (carried out by selecting the table or chair), moving away from the table (navigating away from the space), and asking questions (done by interacting with buttons on the 2D overlay). Navigation was found to be too fast for some of the users in the VE and as a result the speed settings were decreased. Observation of facilitator prompts or incorrect user actions indicated where usability problems occurred,

again to perform additional tasks. Throughout VE use the user may interact verbally with other inhabitants of the *Social Café*.

When participating in a CVE, the visual appearance of each user's embodiment and how their actions are portrayed to others has to be considered. Each participant will typically embody an avatar with a different appearance. This serves both to allow an obvious means of distinguishing inhabitants from one another and may be utilised to purvey a sense of anonymity or customise the way a user wishes to appear to others. The *Social Café* allows a sense of gaze direction to be achieved with the avatar's head movements being independent of body motion (achieved by moving the mouse in the required direction). Different modes of input device could also provide further means of non-verbal communication, such as motion-tracking equipment allowing users to perform gestures. Users also have the ability to view the environment from a number of different perspectives, such as from eye-level, from behind and above, or looking directly into the embodiment's face.

It is also advantageous to visually identify the source of verbal communication in a CVE; in a physical environment this is achieved by a sense of the direction of the users' voices and by visibly identifying who is talking at any one time. Although mouth animations are possible

and qualitative data from video recordings were used to explain why these problems occurred. For example, many of the problems with sitting at the table occurred because the user did not realise that they had to switch from the joystick input device (that they were using to navigate) to the mouse (which they needed to use to select objects), or because they did not know which area they had to click on, or because the interactive area was too small. This data was used to inform revisions of both the 3D and 2D interfaces.

The usability study highlighted aspects of the SVE which failed to support or structure appropriate behaviour. For example, after finding out that a seat was free the users could (and sometimes did) move away from that table without sitting down. Although the VE has been designed to allow the user to choose what actions they should take and when, they perhaps needed to be informed that this is not a socially appropriate choice of actions.

It was thought that the majority of problems observed were because the user did not know how to interact, rather than their inability to do so. As well as carrying out some tasks incorrectly, the participants did not make use out of some of the features of the VE that would have helped them, such as the facility to re-play instructions. It is proposed that the next version includes a training environment to show the user how to use features of the interface and then allow them to practise this before using the *AS Café*.

The user group facilitator had also made comments relating to use of the SVE to support learning. It was suggested that each scenario should be presented at three different levels, dependent on the difficulty of the social interaction task that the user had to carry out. At the 'easy' level the user would just have to find somewhere to sit, there would be plenty of empty tables and chairs. The medium level would be the current VE, and the difficult level

set some additional challenges, such as would require the user to borrow a chair from a different table. It was also suggested that some kind of recognition for achievement should be included in the program, but as yet no decisions have been made as to what form this should take.

Users generally liked the CVE *Social Café* and could navigate the environment reasonably well, although they did experience initial problems with use of the virtual space and kept bumping into each other. This may have been because they didn't have a true sense of their avatar's body size or because their viewpoint didn't show the object they were navigating (i.e. the viewpoint is positioned from the avatar's eyes looking forward). It was suggested that it may be better if the viewpoint was positioned slightly behind the avatar's head, although this may then cause confusion when interacting with other avatars. The solution so far has been to scale up the environment to provide more exaggerated space. This has helped to improve navigation.

Some problems were experienced with object interactions, mostly relating to the unusual behaviour of virtual objects. For example, objects placed in mid-air do not fall down and it is possible to pick things up from an unrealistic distance, such as the other side of the room. Users did not like this and some commented that the appearance, behaviour and interface methods for the *Social Café* would have to be much more realistic in order for it to facilitate learning of social skills. Interestingly, these issues were not raised in relation to the SVE *AS Café*; possibly the change in perspective from external viewer to inhabitant of the virtual environment is influencing users' attitudes towards, and subsequent expectations of, the virtual environment as a replication of the real world. Further investigation of these issues is required before we can comment upon this.

3.2 Experimental studies of use and understanding of virtual environments

In addition to the usability studies, experimental studies are being used to assess user interpretation of virtual environments with respect to the real world. These studies will inform our interpretations of user performance in virtual environments and provide an indication of the potential transfer of social skills to real world execution. Two studies have so far been conducted which have examined user behaviour in single user environments developed or adapted specifically for the purpose of study.

a VE … offers the potential for role-play in a simulated controlled environment

The first experimental study was conducted to examine how users behave (verbally and non-verbally) when using an early version of the SVE café (Brown et al. 1999) and how they understand and react to 'people' within the VE. This experiment compared performance and responses from participants with ASDs and control participants matched on verbal IQ (VIQ) and performance (non-verbal) IQ (PIQ). Preliminary observations of performance suggest that users with ASDs found the VE interesting, fun and easy to understand. When asked questions about the VE and specific elements within it, participants generally accepted that the VE was representing a real environment and made appropriate inferences about what the avatars were doing (Parsons and Mitchell 2001). One of the issues highlighted by the study was that participants with ASDs may have difficulties in respecting personal space of other characters within a virtual environment; it was noticed that several users navigated between two avatars positioned at the bar despite their being a large empty space at the side of them. Informal observations suggest that members of the group of pupils with ASDs were more likely to demonstrate this behaviour (50% of the group), compared to the verbal IQ and non-verbal IQ matched groups (9% and 25% respectively).

As a follow-up to this finding, a further study investigating the understanding of personal space within SVEs has been carried out. Pupils with ASDs were again matched with comparison groups on the basis of gender, age, VIQ and PIQ. All participants were asked to navigate a route to the counter to get a drink from the waiter. There were eight conditions in total: four in which it was socially appropriate to walk straight ahead to the counter (the direct route to the counter was bordered by either objects or people with their backs to you), and four in which it was socially inappropriate to do so (the direct route was bordered by people facing each other, ostensibly engaged in conversation). In each case, there was sufficient space to walk between the people or the objects en route to the counter, or the user could choose to take a detour around the people/objects, thereby avoiding them altogether. Although the results have yet to be formally analysed, all participants (regardless of group membership) did not discriminate between the appropriate and inappropriate conditions. Instead, the majority of participants chose either one route or the other (i.e. straight ahead to the counter, or around the people/ objects), and adhered to that choice across conditions. Interestingly, during questioning, many participants (both with and without autism) acknowledged that it was socially inappropriate to walk through a gap in which people were engaged in conversation. A common justification for behaving as they did in the VE was because, "…it's just a VE, and so it doesn't really matter what you do". Despite this assertion, the majority of participants

avoided walking across grass and flowerbeds en route to the café, "…because it would not be appropriate to do that – you could break the flowers". Consequently, one of the main challenges facing the project is to investigate why some social conventions seem to be reflected in behaviour during VE use (not walking across flowerbeds), whilst others do not (respecting the personal space of people in a café).

4. Discussion

The application of VEs for social skills learning in adults with AS is considered advantageous because it offers the potential for role-play in a simulated controlled environment. In a CVE users can interact with others via navigation of their avatar and direct verbal communication using headset microphones. This offers the facility to practise real conversations in a role-play scenario without the added intimidation of face-to-face contact. Our research has not yet progressed far enough for us to comment upon outcomes from role-play sessions in the CVE, this will be the focus of our next research phase, but early indications suggest that users like the technology and consider that it could be useful to support social skills learning.

SVEs, by their very nature, offer limited opportunity to explore social interaction. Whilst it is possible that such environments can be used to replicate life situations and scenarios which a user can explore, their real advantage for training is in procedural behaviour (for example, learning the sequence of actions required to achieve successful completion of a task). In the *AS Interactive* project, we decided that SVEs could be utilised for training specific aspects of social interaction in a structured manner. The limited number of options available at any given decision point should make it easier for users to learn appropriate choices. Moreover, the SVE can be developed at different levels, representing progressively more complexity and options

available to the user. This 'scaffolded' learning approach has been successfully utilised in education technology and may offer a suitable method for building an understanding of individual components required for social interaction. By focusing on specific aspects of social interaction, we may be able to use this approach to examine generalisation of skills from one context to another. For example, we propose to replicate the task of choosing where to sit in other social contexts, such as public transport, to examine whether individual performance in one context is demonstrated in the other.

The ultimate aim of the project, of course, is to support learning of social skills which can then be applied in the real world. Assessment of user behaviour within a VE is only useful if we know that they understand how the training environment represents and applies to the real world. Results from our initial experimental studies have indicated that users (both with and without AS) appear to ascribe real-world conventions to behaviour in some virtual tasks but not in others (e.g. not walking across flowerbeds but walking 'through' personal interaction space). User explanations for this behaviour suggest that, at some times, users interpret the VE like a computer game in which their actions have no real world consequences and so their behaviour 'does not really matter'. What is not clear is why this applies only in some situations but not in others. One possible explanation is that users are content to apply social rules when decision choices are simple (e.g. go across the flowerbeds or around them) but when the options becomes more complex (involving making assumptions about the social interactions between other characters), it is hard to make realistic decisions and so users opt for an easy way out, and satisfy themselves that it doesn't really matter anyway because it's only a game. It has been suggested that the interpretation of the VE as a 'real' scenario may be influenced by how tasks are presented to

users and what cues are used to 'set the context'. This is obviously an important issue and will be addressed in follow-up experiments. As a first step towards this, it will be interesting to examine how users react to the same task and scenario presented in the CVE; will users still navigate through the social space between avatars engaged in a real conversation?

We have successfully established collaboration with appropriate user groups and they have all participated in development of the first VE prototypes produced. The review of the SVE yielded different information from each group of reviewers. The professional group commented upon general design and aesthetics; use of colours, symbols and presentation of prompts. Users commented upon usability and design of the interface. Whilst most users enjoyed using the VE and needed little assistance, usability problems were identified relating to navigation around the VE, inconsistencies in interaction metaphors and the need for instruction prompts. Teachers commented upon functionality and issues relating to generalisation and presentation of this as learning material.

At the end of the first phase of study we can conclude that VEs are acceptable to users with AS and users do sometimes interpret VEs as being representative of real environments. However, there are still many outstanding questions to address concerning users' interpretation of other people within the virtual environment, how should we provide the appropriate scene setting, and how we can make effective use of progressive learning. In the next phase we intend to build upon our relationship with teachers and training professionals to support planning and decision-making with respect to final development and implementation. As a first step toward this we will be installing the SVE and CVE into a school for children with ASDs to allow us to conduct *in situ* evaluations. It is hoped that this will enable us to further investigate some of the issues raised in our preliminary studies with a view to defining principles and design requirements for the application of VEs as part of a social skills training programme. A similar approach is being taken with adults with AS in National Autistic Society run social groups.

Acknowledgements

References

Baron-Cohen, S. and Bolton, P. (1993) *Autism: the facts.* Oxford University Press, New York.

Baron-Cohen, S., Leslie, A.M. and Frith, U. (1985) Does the autistic child have a 'theory of mind'? *Cognition* **21** 37–46.

Beardon, L., Parsons, S. and Neale, H. (2001) An interdisciplinary approach to investigating the use of virtual reality environments for people with Asperger Syndrome. *Educational and Child Psychology* **18**(2) 53–62.

Benford, S., Bederson, B. B., Åkesson, K., Bayon, V., Druin, A., Hansson, P., Hourcade, J. P., Ingram, R., Neale, H., O'Malley, C., Simsarian, K., Stanton, D., Sundblad, Y. and Taxén, G. (2000). Designing storytelling technologies to encourage collaboration between young children. In *Proceedings of Human Factors in Computing Systems* (CHI 2000). ACM Press, pp. 556–563.

Brown, D.J., Neale, H.R., Cobb, S.V. and Reynolds, H. (1999) Development and evaluation of the virtual city. *The International Journal of Virtual Reality* **4**(1) 28–41.

Cobb, S., Kerr, S. and Glover, T. (2001) The AS interactive project: developing virtual environments for social skills training in users with Asperger's Syndrome. *Proceedings of workshop on Robotic and*

virtual interactive systems in autism therapy. University of Hertfordshire, Hatfield, UK (forthcoming).

Eastgate, R.M. (2001) *Structured development of virtual environments.* PhD Thesis, University of Nottingham.

Frith, U. (1989) *Autism: explaining the enigma.* Blackwell, Oxford.

Howlin, P. (1997) *Autism: preparing for adulthood.* Routledge, London.

Klin, A. and Volkmar, F.R. (2000). Treatment and intervention guidelines for individuals with Asperger Syndrome. In Klin, A., Volkmar, F.R. and Sparrow, S.S. (eds.) *Asperger Syndrome.* The Guilford Press, New York.

Meakin, L., Wilkins, L., Gent, C., Brown, S., Moreledge, D., Gretton, C., Carlisle, M., McClean, C., Scott, J., Constance, J. and Mallet, A. (1998) User group involvement in the development of a virtual city. In Sharkey, P., Rose, D. and Lindstrom, J-I. (eds.) *The 2nd European conference on Disability, virtual reality and associated technologies.* University of Reading, pp. 1–9.

Mitchell, P., Saltmarsh, R. and Russell, H. (1997) Overly literal interpretations of speech in autism: understanding that messages arise from minds. *Journal of Child Psychology and Psychiatry* **38** 685–691.

Neale, H. (2001a) Using virtual reality to teach social skills to people with Asperger's Syndrome: explaining virtual reality and user-centred methodology. *Proceedings of the 12th Annual Durham International Conference on Autism.* Autism North (in press).

Neale, H. (2001b) Guidelines for design of virtual environments for users with Autism. *Proceedings of workshop on Robotic and virtual interactive systems in autism therapy.* University of Hertfordshire, Hatfield, UK (forthcoming).

Neale, H., Cobb. S. and Wilson, J.R. (2001) Involving users with learning disabilities in virtual environment design. *Proceedings of the 9th International Conference on Human-Computer Interaction (HCI 2001).* New Orleans, LA.

Parsons, S. and Mitchell, P. (2001). Virtual reality and people with Autistic Spectrum Disorders: informal observations from the AS interactive project. *Proceedings of the 12th Annual Durham International Conference on Autism.* Autism North (in press).

Pollard, N.L. (1998) Development of social interaction skills in preschool children with autism: a review of the literature. *Child and Family Behavior Therapy* **20** 1–16.