

Development of social skills amongst adults with Asperger's Syndrome using virtual environments: the 'AS Interactive' project

S Parsons^{1*}, L Beardon², H R Neale³, G Reynard⁴, R Eastgate³, J R Wilson³, S V G Cobb³, S D Benford⁴, P Mitchell¹ and E Hopkins²

¹ School of Psychology, University of Nottingham, Nottingham, UK

² The National Autistic Society, Castle Heights, Maid Marian Way, Nottingham, UK

³ VIRART (Virtual Reality Applications Research Team), University of Nottingham, Nottingham, UK

⁴ CRG (Communications Research Group), School of Computer Science and Information Technology, University of Nottingham, Nottingham, UK

*lpxsjp@psychology.nottingham.ac.uk

ABSTRACT

People with High-Functioning Autism, or Asperger's Syndrome (AS), are characterised by significantly impaired social understanding. Virtual environments may provide the ideal method for social skills training because many of the confusing inputs in 'real world' interactions can be removed. This paper outlines the rationale and methodology of the *AS Interactive* project. This multidisciplinary project incorporates a user-centred design and aims to develop and evaluate the use of virtual environments to support and enhance social skills amongst adults with AS. The potential for the use of Collaborative virtual environments for developing social awareness is also discussed.

1. INTRODUCTION

1.1 Background to Autism and Asperger's Syndrome

Asperger's Syndrome is a sub-category of the pervasive developmental disorder Autism (DSM-IV, American Psychiatric Association 1994). Autism is a "spectrum" disorder (Wing, 1996), ranging from 'classic' autism with severe learning disabilities at one end, to high functioning autism (HFA) and Asperger's Syndrome (AS) at the other. In between lie people with autism or autistic-like behavioural syndromes, with varying degrees of associated learning disability. Although IQ levels vary along the spectrum, all individuals diagnosed with an autistic spectrum disorder are defined by specific deficits, including a marked impairment in social skills. The difficulty with social interaction is manifested by a lack of reciprocity and restricted ranges of interests and behaviour (Nordin & Gillberg, 1998). People with autism often show abnormalities in the use of language, including egocentric and/or echolalic speech (repetition of words or phrases) and an overly literal interpretation of words and phrases. A limited understanding of social norms and expectations may often lead to inappropriate behaviour and can result in difficulties forming and sustaining friendships. An anecdotal report from Temple Grandin – an American academic with AS – indicates just how difficult social situations can be: "[she avoided dating]...finding such interactions completely baffling and too complex to deal with...[because]...she was never sure what was being said, or implied, or asked, or expected" (from Sacks, 1995; p.272).

Like Temple Grandin, many people with AS or HFA manage to achieve high levels of academic achievement and live independently (e.g. Szatmari, et al, 1989). Indeed, IQ is the best known predictor of outcome for people with autism spectrum disorders (Nordin & Gillberg, 1998). People with AS tend to have relatively normal levels of cognitive skills and tend not to exhibit early language delays (Howlin, 1998). Their narrow range of interests and often, obsessive focus on one particular topic may lead to superior knowledge in a specific area of expertise. Nevertheless, despite relatively good outcome in terms of academic attainment and personal/life skills, people with HFA and AS remain significantly impaired in social understanding (Gillberg, 1998; Nordin & Gillberg, 1998). This can lead to social exclusion and failure to maintain employment due to difficulties in making friendships and communicating ideas. Depression, and other secondary psychiatric disorders, are especially common amongst people with HFA and AS (Tantam, 1988), and there is a higher than average incidence of suicide within this population (Wing, 1981).

1.2 General use of computers in Autism

Due to the difficulties with social interaction that people with AS face, the idea of providing less threatening situations in which skills can be practiced and learned seems intuitively appealing. Computer assisted learning (CAL) has been suggested as an ideal way to present information in a way that reduces the potentially confusing and anxiety-inducing, multi-source inputs that characterise 'real world' social interactions (e.g. Moore, 1998; Moore, et al, 2000). For example, there are non-verbal features (such as gestural, postural and facial information) and verbal features of communication (such as intonation and other paralinguistic cues). A computer-based environment may present an ideal medium for reducing the number, frequency and saliency of this type of information; thereby allowing basic skills to be learned in the absence of competing and distracting cues. Additionally, Swettenham (1996) suggests that computers may be especially appealing to people with autism because they provide a consistent and predictable environment in which the pace of working can be suited to individual needs.

There is some evidence to suggest that computers can lead to successful learning outcomes for people with autism. Heimann, et al., (1995) used an interactive multimedia computer program to teach reading and communication skills to children with autism. Children showed significant vocabulary gains during the training period, and were highly motivated by, and interested in, the computer-based tasks (similar results have been found for teaching language to children with other communication disabilities; Schery & O'Connor, 1997). Chen and Bernard-Opitz (1993) directly compared personal instruction to computer-assisted instruction for four children with autism on a number of tasks. Increases in motivation and decreases in problem behaviours were noted during computer-based instruction, but this was not accompanied by significant improvements in learning (compared to personal instruction). However, there were only four children included, all of whom were young (aged 4-7 years) and relatively low-functioning. Low mental age might account for the failure to demonstrate significant improvements in knowledge gain. Individuals with higher IQ might fare better with CAL approaches.

Targeting older participants and focusing on social understanding, Rajendran & Mitchell (2000) employed a Bubble Dialogue program in which two adults with AS could type in thought and speech content for story protagonists in a variety of social situations. The dialogues were useful in helping people with AS to consider the implications of thought and speech in social situations. However, there were no indications that the intervention with the bubble-dialogue program improved the participants' interpersonal understanding in the 'real world' (based on scores from a behavioural checklist developed by Frith, et al., 1994). Many other studies have attempted to teach people with autism how to improve their understanding of other people's mental states i.e. their 'mentalising' ability (e.g. McGregor, et al., 1998a & b; Hadwin, et al., 1996; Swettenham et al., 1996; Ozonoff & Miller, 1995). This ability is crucial for understanding why others behave in particular ways, and for interpreting language in terms of what the speaker *means* (rather than simply what they *say*). However, all have indicated that participants fail to generalise the rules learned during instruction to other, novel, tasks. This is also true of one intervention that used a computer to teach mentalising rules to children with autism (Swettenham, 1996).

Overall, interventions that have tried to teach people with autism about other's mental states have met with limited success. Computer-based tasks, on the other hand, have been somewhat successful in teaching reading and language and have proved to be motivating and fun for people with autism. However, Howlin (1998) voices concern over the use of computers for people with autism. She suggests that care needs to be taken when using computer-based tasks because they could encourage reliance on the non-human interaction of the computer. This could lead to an obsession with the technology and a resultant decline in 'real' social interaction. Consequently, Howlin suggests that some social interaction should be incorporated alongside CAL, but ideally, social skills training should take place *in situ*. The problems with *in situ* social training are that it can be extremely labour intensive, difficult to manage, and incorporates all of the elements of social interaction that people with autism find threatening, confusing and frightening.

1.3 The value of virtual environments for people with Autism

Virtual environments (VEs) may provide the ideal method for social skills training: a computer-based task which can control the level of inputs the user receives, but shares more features in common with the 'real world' through the use of sophisticated graphics and design. The shared features between virtual and real worlds may facilitate the generalisation of skills from the former to the latter. The lack of shared features between previous training tasks (summarised above) and the 'real world' may, in part, explain the difficulties experienced in trying to utilise learned skills in more naturalistic settings. Moreover, VEs could incorporate a certain level of social interaction through the participation of carers/parents sitting alongside the person with autism (Murray, 1997), as found in the use of desktop virtual environments (Neale, 1997; Neale et al., 1999). This could help to assuage the concerns of those who fear that the computer could become the only source of interaction that the person with autism finds tolerable.

Clancy (1996) describes the usefulness of VEs for people with particular disorders, including autism (also Trepagnier, 1999). The main benefit of VEs is that users can practice skills safely, without experiencing potentially dangerous real world consequences. For example, patients can experience a 'virtual airplane' in the hope of attenuating flying phobia, or children with autism can learn the rules of how to cross the road safely. A one-day seminar organised jointly by the U.K. National Autistic Society and the University of Nottingham also concluded that VR technology could be an extremely useful approach for teaching life skills to people with autism (Neale, 1998). This was based on the work of VIRART at the University of Nottingham, who developed a Virtual City for children and adults with learning disabilities to learn and practice a series of everyday skills leading towards independent living (The Life Skills project: Brown et al., 1999). Scenarios within the program represent procedures and task sequences such as selecting items in the supermarket and paying for them, planning a bus journey, ordering food and drinks in a café and preparing a meal in the home.

Generally, there is much anecdotal support for the possibility of using VEs to facilitate social skills in people with autism. However, there is a paucity of direct evidence to support the idea. Strickland (1996) presents one of the few attempts to expose people with autism to VEs. She applied a fully immersive VR system, including a headset, to two young, minimally verbal children with autism. The VE consisted of a simplified street scene, which, periodically, showed a car moving down a street. Both children behaved as if they were tracking the cars down the street (by turning their head and body in the right direction) and walked towards objects in the virtual world. Whilst this may provide preliminary support for the idea that children with autism can use virtual environments, there is a long way to go before instances of knowledge gain can be demonstrated using this approach. Moreover, although it is stressed in the paper that VR headset wearing was not forced, it is clear that they were not popular with the children. One child took three sessions (within a 15 minute period) to accept the headset and sweets had to be used as enticements. Additionally, the children were unable to verbally express any discomfort at the wearing of the headset, but when they started to support the heavier, front of the headset, with their hands it became noticeable that they were not comfortable with it.

Eynon (1997) avoided the difficulties associated with fully immersive VR in his AVATAR program, instead preferring to use desktop VEs (i.e. a user/computer-screen interface). These were developed in conjunction with VIRART and based on the Virtual City's 'House World.' Children with autistic spectrum disorders were included in the initial pilot phase of the study, and three children with 'communication disorders' formed the final participant group. Trials suggested that the children were attentive, could focus on the presented activities and achieved meaningful interaction with the program. However, the usefulness of the AVATAR project for people with autism is not clear since specific diagnoses, ages and cognitive abilities of the children were not reported. Nevertheless, the study suggests that a desktop interface could be a useful approach for children with communication disorders. Interaction with objects within the environment can be mediated by interaction with another person sitting alongside the user.

1.4 Collaborative virtual environments and social interaction

Another way of achieving 'social' interaction through VEs is through the use of Collaborative VEs (CVEs). CVEs allow participants to share the same virtual world over a computer network. There are a number of defining features of CVEs (Benford, et al., 1994):

- (1) Navigation: each participant steers their own viewpoint through the world.
- (2) Embodiment: each participant is directly represented by a graphical object called an 'avatar'.
- (3) Communication: participants may exchange messages using some combination of audio, video, text and graphics.
- (4) Interaction: participants may directly manipulate virtual objects within the world.

These features could have direct value for people with autism. In particular, more 'realistic' social situations can be presented via the computer because participants can interact with each other and communicate in a variety of ways. This means that interaction within the virtual world can be more dynamic and flexible (like the real world, and unlike the fixed response patterns within single-user VEs), but less threatening for people with autism due to a number of factors:

- (a) The user has *active control* over their participation in the environment. This may boost confidence for people who feel 'out of control' in normal social situations.
- (b) Interaction can take place *without face-to-face communication* (Hindmarsh et al., 1998), which many people with autism find particularly threatening.

- (c) The level and number of non-verbal and verbal features of communication can be *directly controlled* and manipulated.
- (d) Interaction takes place within an environment that is *stable and familiar*, unlike the constantly changing real world environment.
- (e) Communication can occur in a *slower-paced* environment. CVEs tend to offer slower, less responsive reactions than in physical environments, but participants have been shown to develop adaptive strategies as a way of coping with these (Hindmarsh, et al., 1998). Slowing down the rate of interaction may provide time to think of alternative ways of dealing with particular situations.
- (f) Participants may use different equipment to access the same CVE, enabling people with *varying levels of ability* to interact together.
- (g) CVEs can be tailored to *individual needs* in terms of features of the environment that can be manipulated. Individualisation may be crucial to the success of intervention or instruction (Higgins & Boone, 1996).

The combination of these benefits makes the use of CVEs as aids to the development of social skills an extremely interesting and exciting prospect. Indeed, the appearance of chat rooms on the Internet specifically catering for people with AS (e.g. 'Aspiechat'; see Reference section for details) suggests that multiple users can use the same virtual environment effectively. However, given the lack of systematic research into the usefulness of VEs for people with autism, any research project must first address usability issues of single-user VEs before moving on to investigate whether CVEs offer additional advantages. The following section outlines how we intend to approach these challenges in the *AS Interactive* project.

2. PROJECT RATIONALE

Summarising the background literature: people with autism and AS suffer severe impairments in social skills and understanding; traditional approaches to developing social skills through teaching 'mentalising' rules fail to show any real world benefits; computer-based learning has distinct advantages for people with autism; VEs and CVEs present potentially valuable settings for providing a new approach to social skills development; and there is a need for new and systematic research into the value and benefit of VEs and CVEs for people with autistic spectrum disorders. In response to these points, the overall aim of the *AS Interactive* project is to develop and evaluate the use of virtual environments to support and enhance social awareness and social skills amongst adults with AS.

According to Howlin (1998), people with AS are "... the least well served or understood " and "... may require even more highly specialised help than those with global learning difficulties" (p.317). This is because people with AS are often required to 'fit in' to the 'normal' world due to relatively normal cognitive abilities and (often misleading) competence in the use and understanding of language. However, severe impairments in understanding the subtleties of social interaction, coupled with some insight and knowledge of their disorder, leaves people with AS extremely vulnerable, anxious and in need of appropriate help. Facilitation of social skills in work-related situations may be particularly important since the ability to gain and maintain employment contributes significantly to overall feelings of capability and higher self-esteem. Consequently, one of the eventual aims of the project is to focus on social skills that might be especially relevant to work-related contexts.

AS Interactive is a three-year program of research and development funded by the Shirley Foundation, which started in April, 2000. It combines expertise in autism research with expertise in VR technology development and its application for users with special needs at the University of Nottingham. Collaboration with the U.K.'s National Autistic Society will ensure that the needs of the users are addressed and help steer the project towards a useful and usable end-product. The researcher from the NAS (L.B.) is responsible for recruiting users with AS from schools and social groups. He will also play a key role in the evaluation and assessment of the appropriateness of the design and content of VEs for people with AS. Initially, the project aims to assess the potential feasibility and acceptability of VEs for adults with AS. Both single-terminal and collaborative VEs will be reviewed in order to identify features that will be useful for social skills training, and define a suitable interface for users with AS. Ultimately, it is expected that CVEs will be developed replicating one, or more, work-related contexts; these will be available to a wide range of users on the Internet. Specific social interaction scenarios will be built in to these environments to allow training and practice of appropriate social skills.

Figure 1. *Model of the design and development process of virtual environments for people with Asperger's Syndrome.*

3. METHODOLOGY

3.1 User Groups

Following from the research methods successfully employed during the Life Skills project (Brown, et al., 1998; Cobb et al., 1998; Meakin et al., 1998), *AS Interactive* will employ a user-centred design and evaluation methodology. Two groups of users are involved in the project. A summary of their roles clarifies how the user groups will contribute to the design and development of particular VEs (see also Figure 1 which provides a model of the design and research process).

A. The **Collaborative User Group** consists of adults recruited from a social group for people with Asperger's Syndrome. This group will be involved in an iteration process of review and development of an existing VE. That is, they will advise the research team about the appropriateness and usability of VEs for people with AS and will help to inform design specifications for future VE development. Initially, single-terminal VEs will be presented to the group members for comments. A few members of the Collaborative User Group will also assess CVEs. The particular CVE to be reviewed is yet to be decided, but will be guided by the responses to the single-user VE trials in order to identify suitable tasks. Feasibility and acceptability are key considerations in the development of CVEs since they have not previously been employed with special needs users.

B. The **Participant User Group** comprises adolescents with AS, aged 13-19, who have been recruited from special needs schools. This age group represents the target user population because it includes individuals who are working towards transition from school to work or college, and those who are very close to it ('transition' programmes within schools tend to start with pupils from around the age of 13/14 years). Therefore, this group could benefit directly from work-related social skills training at a time when moving in to a work environment is a priority. The participant group(s) will be included in formal studies to evaluate the suitability and usefulness of virtual environments for social skills training.

3.2 What VE will be reviewed?

A modified version of the Virtual Café, within the existing Virtual City (Brown et al., 1998), will be used as the basis for initial user assessment. The VE is implemented using Superscape VRT and run on Pentium PC's or laptop computers. The Café is accessed by a user at a single terminal. The user can perform a number of

different tasks in the café, including sitting at a table, ordering food from a menu, ordering and paying for drinks at the bar and using the bathroom facilities. Instructions to users within the café appear in pictorial, written and/or spoken format. Movement around the café is achieved with a joystick and interaction with objects in the VE (e.g. how much money to pay the waiter) is achieved with the mouse.

The Café was chosen because it represents a social environment. Although dynamic interaction between characters in the café is not available at the present time, the café offers potential for virtual social interaction and could allow the development and refinement of target social skills before work-related environments are produced. The Collaborative User Group may suggest awkward situations that could arise in a café environment. These could be incorporated into the VE so that the users can gain some practice at skills which they identify as particularly problematic.

3.3 How will the VE be reviewed?

The first stage of the project involves gaining feedback on design and usability from the Collaborative User Group. This process will take place over three separate sessions:

Session 1. Users will use and explore the Virtual Cafe. Their comments will be audiotaped and/or videotaped to show to the Research Team. The purpose of this session is to allow familiarisation with the VEs and to gauge general ideas about problems/design issues. Following this session, specific questions will be tailored to the comments of each group member to be expanded upon in Session 2.

Session 2. The users will be asked to review the same VE whilst sitting alongside the Research Team member from the NAS. This is so that any issues highlighted from the tapes of the first session can be targeted at the relevant points in the program. It is hoped that this method of individualised questioning will help to identify specific design issues that can be tackled before Session 3.

Session 3. Some of the design issues highlighted in Session 2 will be implemented so that the group can see how their comments contribute to the development of the VE. Group discussion will reveal whether the changes are satisfactory and meet expectations. The need for further modifications can also be discussed.

The following stage will be to begin formal assessments of the use of VEs by people with AS, using the Participant User Group. In the first instance, the same VE viewed by the Collaborative group will be presented to the participants and their performance videotaped for later analysis. Fundamental issues will be investigated such as can people with AS use and understand the VE sensibly? How do they behave (verbally and non-verbally) when using the VE? Is there something specific about VEs that makes them particularly easy/difficult for people with AS? To gain a clearer idea of how the technology is used by people with AS, their interactions with the technology will be compared to other groups of users, such as people with learning disabilities, and normally-developing adolescents. Additionally, participants with AS will be tested on a number of standardised assessments in order to see whether particular profiles of cognitive ability are predictive of performance in the VE.

3.4 What do we expect the users to comment upon?

People with AS are characterised by idiosyncratic likes/dislikes and obsessive interests as well as a tendency to focus on details, rather than the general picture (Frith, 1989). Consequently, there may be unexpected aspects of the VE that the users concentrate on. This may help us to decide which aspects of the environment might be too 'attention grabbing' for people with AS and, hence, need to be modified during VE development. Idiosyncratic interests aside, we might find general features of the VE which users suggest need modification. For example, users may comment upon design issues such as the format in which instructions are presented. Some users may prefer to hear the instructions spoken, whilst some may want to see them written on the screen. There may also be suggestions on input devices, whether they are easy/difficult to use, what improvements could be made etc. Similar comments from many individuals about certain features of the VE will provide a good indication that a particular design or interface issue needs to be addressed.

3.5 What do we expect to find from the initial user trials?

At the end of the first year the expected outcome will be an understanding of the acceptability of VEs to adults and adolescents with AS. In particular, the issues that need to be defined are:

- (1) interface suitability for the target users (e.g. input devices and appropriate display media). Informal comments from the Collaborative User group and formal observations from the Participant User Group will help us to produce a VE that is tailored to the specific needs of people with AS.
- (2) appropriate features of VE design (e.g. content, layout, use of text, frequency and type of instructions). Although it is hoped that there will be some agreement about certain design issues, an important point to

keep in mind is that certain aspects of the environment should be amenable to individualisation. That is, there should be choices built into the VE (e.g. the use of text and/or speech for giving instructions) which the user can adapt to suit their own needs.

- (3) utility of the VE as an educational tool (e.g. efficacy of the tool in terms of measurable changes in participant performance). Results from the formal assessments of the Participant User Group will enlighten us as to whether significant improvements in knowledge or skill gains can be achieved through the use of VEs.

3.6 How will the project develop after the first year?

Years two and three will continue and expand the program of VE development and testing. The Collaborative User Group will be involved throughout the process to review new environments and provide feedback about modifications and improvements. Formal assessments within the Participant User Group will follow-on from the input of the Collaborative group, in order to test the usefulness, feasibility and acceptability of VEs and CVEs for people with AS. One of the main considerations will be the development of a usable end-product that will afford real benefits for users in terms of developing and practicing specific social skills. The development of ideas and knowledge gained through the research process will ultimately enable us to generate a product that can be accessed by as many users as possible. The Internet provides the perfect opportunity for allowing users to interact in a virtual world, which is developed and controlled by, and individualised and tailored to, people with AS.

4. CONCLUSIONS

People with AS are in need of a training environment that can help them cope with the demands of social interaction. Virtual reality offers a stable and predictable environment in which interaction can take place without the anxiety-inducing plethora of non-verbal and verbal information that characterises social interactions. Consequently, the role of Virtual Reality in the remediation of social difficulties for people with AS could be extremely powerful. The value of the approach taken by the *AS Interactive* project is that the insight and experiences of users with AS will have a direct impact on the development and design of new VEs for other people with AS. In this way, it is hoped that the end-product will be of significant benefit to users because the very specific needs of people with AS will have been investigated and addressed from the outset. Only if we listen to the voices of the people that we are trying to help can we gain the knowledge necessary to translate information into action.

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