review

The potential of virtual reality in social skills training for people with autistic spectrum disorders

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Abstract

Background People with autism experience profound and pervasive difficulties in the social domain. Attempts to teach social behaviours tend to adopt either a behavioural or a ‘theory of mind’ (ToM) approach. The beneficial aspects and limitations of both paradigms are summarized before an examination of how virtual reality technology may offer a way to combine the strengths from both approaches.

Methods This is not an exhaustive review of the literature; rather, the papers are chosen as representative of the current understanding within each broad topic. Web of Science ISI, EMBASE and PsycInfo were searched for relevant articles.

Results Behavioural and ToM approaches to social skills training achieve some success in improving specific skills or understanding. However, the failure to generalize learned behaviours to novel environments, and the unwieldy nature of some behavioural methodologies, means that there is a need for a training package that is easy to administer and successful in promoting learning across contexts.

Conclusions Virtual reality technology may be an ideal tool for allowing participants to practise behaviours in role-play situations, whilst also providing a safe environment for rule learning and repetition of tasks. Role-play within virtual environments could promote the mental simulation of social events, potentially allowing a greater insight into minds. Practice of behaviours, both within and across contexts, could also encourage a more flexible approach to social problem solving. Virtual environments offer a new and exciting perspective on social skills training for people with autistic spectrum disorders.

Keywords autism, executive function, mental simulation, social skills training, theory of mind, virtual reality

Introduction

People with Asperger syndrome (AS) and other autistic spectrum disorders (ASDs) experience profound difficulties in the social domain. This can lead to social exclusion, and difficulties in maintaining and sustaining friendships and employment (Howlin 1997). There have been many attempts to
help children with ASDs develop specific social and communication skills in the hope that this will improve social functioning and increase acceptance by peers (e.g. Belchic & Harris 1994). The majority of these interventions have utilized behavioural methodologies and achieved varying degrees of success in improving and maintaining specific behaviours across time and contexts (for reviews, see Pollard 1998; Hwang & Hughes 2000; Rogers 2000). Many tend to target younger children with autism in the belief that learned social behaviours might ameliorate later difficulties in the social domain. There is little doubt that targeting social difficulties at an early age can have extremely beneficial effects (for a review, see Mundy & Crowson 1997).

Very many children with autism may not get the opportunity to participate in early intervention behavioural programmes or research. Fortunately, more recent, cognitive approaches to teaching social skills to people with ASDs have included older children, and adults. These approaches tend to be based on the ‘theory of mind’ (ToM) hypothesis of autism and provide an alternative to behaviour-based techniques. The ToM hypothesis states that the social difficulties in people with ASDs arise through an inability to recognize or think about the mental states of the self and others. Higher-functioning people with autism (e.g. those with AS) have also been included in some of these studies. High-functioning individuals tend to have subtle difficulties which fall outside the scope of the basic behaviours targeted in behavioural ‘peer modelling’ paradigms (e.g. naming a toy correctly in response to a question; McGee et al. 1992).

The efficacy of teaching people with ASDs about mental states in the hope of improving social understanding is rather equivocal. Although most studies report an improvement on the specific skill or task being taught, there are frequent failures to generalize knowledge to different tasks or to real-world situations. Nevertheless, the benefit of demonstrating an increase in understanding mental states, albeit in very specific circumstances, led Howlin (1998) to state that ‘... even this limited success suggests that training packages specifically designed to increase the ability to “mind-read” could be an important and valuable addition to the educational curricula for many children with autism’ (p. 315). Consequently, trying to teach children to think about the mental states of others appears to be an important objective for research on social skills interventions. Surprisingly, this approach is not reflected in recent reviews on current and emerging treatments for people with autism (see the special issue of the Journal of Autism and Developmental Disorders, Volume 30, Number 5, 2000).

The main purpose of the present paper is to highlight the specific advantages which virtual reality (VR) may offer in the realm of supporting social skills amongst people with AS. The review begins with background information about autism, AS and social skills. This is followed by a summary of the effectiveness of behavioural interventions for social skills training. Next, the authors include an overview of the ToM hypothesis of autism before covering some of the research utilizing ToM principles to teach social understanding to people with ASDs. They then summarize the key strengths offered by ToM social skills training and end by outlining how VR encompasses the benefits of both the behavioural and cognitive approaches, potentially offering a powerful and flexible tool for tackling deficits in social skills for people with autism.

Background on autism and social skills

Autism is a ‘spectrum disorder’ (Wing 1996) that is diagnosed at the behavioural level according to a triad of impairments in communication, socialization and imagination (Wing & Gould 1979). The spectrum ranges from ‘classic’ Kanner-type autism with severe learning disabilities at one end of the continuum to high functioning autism (HFA) and AS at the other. Even though individuals with the same diagnosis can vary according to level of associated learning disability, a fundamental difficulty with social interactions is common to all people with an ASD.¹

At the more able end of the spectrum, there is debate about the value and validity of maintaining a diagnosis of AS separately from HFA (e.g. Ozonoff et al. 1991). In the absence of firm evidence to the

¹For the sake of brevity, the present authors will use the term ‘people with ASDs’ to talk generally about people with an autistic disorder, including AS. Specific terms such as AS and HFA will be used when referring to studies in which the sample group is clearly specified.
contrary, many authors have concluded that the diagnoses should be considered as part of the same spectrum (e.g. Tantam 1988; Gillberg 1998; Manjiviona & Prior 1999). Even very recent discussions of the topic (e.g. Ozonoff & McMahon-Gillith 2000; Volkmar & Klin 2000) admit that the evidence for considering AS and HFA as distinct diagnoses is mixed, and that more research is needed to clarify the issue. Literature relevant to both diagnoses is considered below.

Whilst typically developing children seem to learn the intricacies of social interaction almost effortlessly, the same is not true for individuals diagnosed with an ASD. Widespread impairments in the social-communicative domain are manifest in many ways. For example, people with autism often show egocentric and echolalic speech (i.e. repetition of words or phrases), inappropriate behaviours and language, limited understanding of social norms and expectations, and an overly literal interpretation of speech (Frith 1989; Baron-Cohen & Bolton 1993).

Peculiarities in behaviour may be especially problematic for people at the higher-functioning end of the spectrum. Some individuals demonstrate normal to high IQ levels, and enjoy good outcomes in terms of academic achievements and personal life skills, but still remain significantly impaired in their social understanding (Gillberg 1998; Nordin & Gillberg 1998). This can lead to social exclusion because forming and maintaining friendships can be extremely problematic. People with AS also have the capability to reflect on the implications of their diagnosis for everyday interactions. Consequently, it is not surprising that people with AS or HFA are particularly prone to secondary psychiatric disorders, such as depression (Tantam 1988). More worryingly, Wing (1981) suggested that the incidence of suicide amongst individuals with these diagnoses may be higher than average.

Because of the social difficulties experienced by all people diagnosed with an ASD, emphasis in educational intervention has been placed on social and communicative competence (Klin & Volkmar 2000). The next section summarizes the main strengths of social skills interventions which have utilized behavioural methodologies in order to teach specific skills to young children with autism.

**Behavioural methodologies for social skills training**

Early behavioural methodologies for teaching social skills to (usually) pre-school children with autism focused on the application of operant conditioning principles (e.g. Lovaas 1981). In highly structured one-to-one settings, children with autism receive repetitive drilling in particular behaviours in discrete blocks of trials (e.g. imitating hand waving or completing a puzzle). This approach aims to equip children with fundamental social building blocks from which they could learn, develop and generalize to a broad range of social situations (Frankel et al. 1987). These interventions were often very effective in teaching children new behaviours or skills, but suffered from a lack of generalization in terms of transferring learned behaviours to new tasks or contexts (for discussions of the approach, see Mirenda & Donnellan 1987; Schriebman 2000). The strict discrete-trial learning approach, coupled with a decontextualized, trainer-driven ‘therapy’ environment meant that learned behaviours were context-specific and dependent on immediate reinforcement – a situation almost completely devoid of naturally occurring interactions (Frankel et al. 1987). By contrast, more recent intervention strategies have recognized the importance of embedding interventions within the child’s natural settings, such as home and school. Spontaneously occurring behaviours tend to be incorporated into the programmes, with trainers, teachers, peers or parents responding and reinforcing child-initiated interactions and behaviours. Interventions have led to improvements in behaviours such as greeting, joint attention and more general social behaviour, as well as facilitating generalization and maintenance of effects (for reviews, see Hwang & Hughes 2000; Rogers 2000).

One particularly useful strategy seems to be a script- (or prompt-) fading procedure (summarized in Krantz 2000). This involves initially providing a high level of support or prompting to the children before gradually fading the level of prompts over time. The technique led to an increase in the target behaviour (initiating interaction with a teacher) as well as promoting generalization of the behaviour to unscripted interactions (Krantz & McClannahan 1998). These procedures have also been useful in
helping older children with autism to develop some functional independence, such as going shopping or buying a train ticket (Howlin & Rutter 1987).

Generally, the main behavioural principles of repetition and reinforcement seem to be effective in promoting change in specific behaviours. The techniques tend to offer greater potential for the generalization of learned behaviours if they are embedded in more naturalistic and meaningful contexts. Prompt-fading procedures are also useful for developing and sustaining new social skills. Despite such strengths, these kinds of interventions are sometimes criticized because they ‘... are complex in administration, data collection, and maintenance and generalization procedures, and they require trained staff and focused interventions that extend over weeks to months’ (Rogers 2000, p. 406). Klin & Volkmar (2000) and Rogers (2000) also noted that, because of the above problems, the accessibility and affordability of social skills training programmes to teachers/carers/schools/parents has been frustratingly poor. In short, the field of social skills training ‘... needs to develop successful and efficient intervention approaches that are manualized and packaged for dissemination to a wide variety of community settings ...’ (Rogers 2000, p. 407).

One of the benefits of the ToM approach to teaching social skills is that the tasks are often less complex and easier to implement. Indeed, Baron-Cohen & Howlin (1998) produced a manual to help teachers and parents incorporate ‘mind reading’ tasks into educational programmes. Another advantage, as already stated above, is that more able older people with autism tend to be included in ToM interventions. Consequently, this particular approach may be more relevant to the high-functioning members of the autistic spectrum. The following section outlines the ToM hypothesis of autism before moving on to look at the value of ToM principles for social skills training.

The ‘theory of mind’ hypothesis of autism

One of the most influential approaches to explaining the triad of impairments seen in autism is based on the ToM hypothesis. The term ‘theory of mind’ comes from the work of Premack & Woodruff (1978), who used it to describe the ability to impute mental states to self and others. This ‘mentalizing’ capability supposedly underpins the essential human ability to communicate and interact in a meaningful way. In particular, it is crucial to consider the mental states of others when trying to work out their motives and predict behaviour. Extracting underlying meaning from language is central to the success of conversation. Speakers rarely say exactly what they mean, and therefore, listeners need to fill in the ‘gaps’ by appealing to the context of the conversation, and the speaker’s belief framework, to work out what was meant. People with autism find this especially difficult and are notorious for making overly literal interpretations of speech (e.g. Mitchell et al. 1997). They also have well-documented difficulties on tasks which require thinking about the mental states of themselves and others.

Many people with autism have difficulty acknowledging false belief. In the test of false belief (Wimmer & Perner 1983), a story protagonist does not witness a change in reality (e.g. some chocolate is moved from a drawer to a refrigerator without the protagonist’s knowledge), and the child participant is asked to infer where the ignorant protagonist will look for the chocolate. Normally developing children pass this task around the age of 4 years and say that the protagonist will look for the chocolate in the drawer (where the protagonist last saw it). In contrast, many children with autism, even with verbal mental ages (VMAs) greater than 4 years, fail this task by reporting that the protagonist will look for the chocolate in the refrigerator (i.e. in the refrigerator; Baron-Cohen et al. 1985). The difficulty with the task seems to arise from the participants’ autism and not their associated learning disabilities, given that a group of individuals with similar intellectual profile but without autism typically made correct judgements of false belief. Seemingly, autism gives rise to difficulty in understanding that people can hold mental states which are different (and separate) from current reality. The failure on this task is often interpreted as an indication that children with autism have a profound mentalizing deficit, leading to social-communicative impairment. Older and higher-functioning people with autism or AS have also experienced difficulties, compared to matched
control groups, on more subtle and complex ToM tasks (Happe 1994), even though they may pass different versions of the false belief task (e.g. Bowler 1992). Given this difficulty with understanding mental states, there have been some admirable attempts to teach ToM skills to people with autism in the hope that such understanding might generalize to real social situations. The following section summarizes the success and limitations of these studies.

**Teaching ‘theory of mind’ to improve social understanding**

One of the main paradigms for teaching people with autism about mental states is to embody a mental state (i.e. a belief) with a tangible counterpart in reality (e.g. a photograph). For example, the protagonist’s belief that the chocolate is in the drawer is shown directly as a photograph of some chocolate in the drawer. Mitchell (1997) and Saltmarsh et al. (1995) argued that this approach is effective because the belief is elevated to the same level of salience as reality, i.e. children who fail false belief tasks do so because knowledge of reality dominates their judgements, rather than because they have a conceptual deficit in understanding thoughts as representational entities (for a contrasting view, see Perner 1991). Generally, this ‘pictorial augmentation’ methodology serves to make thought concrete, which might help people with autism to consider the mental states of others and perhaps generalize this understanding to situations which require ToM understanding in the real world. Most of the following studies incorporate this approach, albeit to varying degrees, alongside the explicit teaching of ToM rules or principles (e.g. if x believes y, then x will do z).

McGregor et al. (1998a) adapted a procedure developed by Mitchell & Lacohee (1991) for use with people with autism. Participants (mean age of autistic experimental group = 17.9 years; mean VMA = 4.8 years) were instructed to post a photograph of the original location of some chocolate into the head of a mannequin doll. For example, the photograph showed a picture of some chocolate in a drawer. Compared to pre-instruction performance, people with autism were significantly better at judging false belief on being taught that the photograph could show them what the doll was thinking, i.e. they were significantly more likely to say that the protagonist thought the chocolate was in the drawer (where she/he left the chocolate). However, unlike normally developing 3-year-olds, the children with autism failed to generalize this understanding to novel false belief tasks.

In a separate study by the same authors (McGregor et al. 1998b), people with autism were helped by the ‘picture in the head’ procedure to judge correctly about false belief scenarios presented on video (participants were aged 9–39 years, with VMAs ranging from 4 to 11 years). However, in both studies, a period of repetitive teaching was necessary before any facilitation resulted, and in the latter study, only a small subset of the individuals were able to apply their understanding of the picture-in-the-head procedure to video scenarios. In other words, people with autism could be helped to pass false belief tasks, but they tended not to generalize this understanding to novel situations.

Similarly, Swettenham et al. (1996) used photographs as an analogue to mental states. The above authors emphasized the rule that seeing leads to knowing, leading to a picture-in-the-head, which can then guide behaviour. This method was successful in promoting correct predictions about the protagonist’s behaviour, but none of the children with autism (mean age = 11.6 years; mean VMA = 6.0 years) used the photographs to infer mental states. Although the children may have learned a strategy for predicting behaviour, they seemed to have no insight that this was based on a mental representation (i.e. the protagonist’s belief).

Other studies indicate that teaching ToM principles to people with autism can be successful in promoting understanding in specific tasks, but there is little sign of generalization from one context to another. Hadwin et al. (1996) devised an intervention programme in which they taught a variety of ToM tasks to children with autism (mean age = 9 years; mean VMA = 5 years) over an intensive 8-day period. The researchers taught general principles for understanding mental states (e.g. seeing leads to knowing) during a variety of tasks of increasing complexity. Children with autism were significantly helped to pass tasks on which they received teaching, but failed to demonstrate any of this understanding on tasks in which they had
received no teaching. In a more ambitious 4.5-month intervention programme, Ozonoff & Miller (1995) taught five normal-IQ adolescents with autism a number of interactional and conversational skills, in addition to principles related to understanding the mental states of others. Their performance was compared to an IQ-matched group of boys with autism who received no training. Whilst the ‘treatment group’ demonstrated significant performance gains in their ability to pass false belief tasks, there was no evidence of improved social competence in the real world based on the ratings of parents and teachers.

Overall, then, it appears that people with autism can be taught to pass false belief tasks, but the benefits of this understanding are restricted to tasks on which instruction has been given. Chin & Bernard-Opitz (2000) argued that this may be because the studies have focused on specific principles or tasks rather than actual ability. Teaching rules decontextualizes knowledge and tasks; unfortunately, it does not create a situation in which the transfer of skills between taught and real contexts becomes possible. This raises the possibility that practising behaviours systematically in a role-play situation could be the ideal way to promote improvements in understanding and behaviour. Indeed, Chin & Bernard-Opitz (2000) were successful in improving the conversational skills of three children with autism (aged 5.11, 7.5 and 7.9 years) through the explicit practising of behaviours, and Mesibov (1984) also reported success in teaching greeting and interaction behaviours. This is by no means a novel suggestion. Practitioners and teachers are keen to promote the benefits of in situ social skills training (e.g. Howlin 1998), and role-playing prior to entering the real world is considered to be a good way of preparing the student for the different types of interactions which they may encounter (Mesibov 1984; Howlin & Rutter 1987; Howlin 1997; Klin & Volkmar 2000).

The main message from the ToM interventions seems to be that teaching explicit rules for understanding and behaviour can improve task-related performance. Teaching rules for social understanding is an approach often emphasized by authors for effective social skills training (e.g. Howlin & Rutter 1987; Klin & Volkmar 2000). Howlin (1997) acknowledged that teaching rules for social understanding may be a near impossible task because of the complexity of social situations and the seemingly innate ability (at least amongst people developing normally) to know how to behave in different contexts. Nevertheless, she argued that rule-based learning may be the best option for people with autism because ‘...without this innate understanding, rules will be all that the person with autism has to guide his or her behaviour, and, imperfect as they are, they will be crucial for acceptable social development’ (Howlin 1997, p. 77). Indeed, Carol Gray’s well-known Social Stories teaching package (Gray & Garand 1993) relies on teaching rules for social behaviour to people with autism in a friendly and supportive environment. Consequently, it is vital that social rules are clearly conveyed in any social skills teaching package. Ideally, the teaching of social rules should also utilize the strengths from the behavioural paradigm. According to Volkmar & Klin (2000), ‘...verbal instructions on how to interpret other people’s social behaviour are often helpful, following explicit guidelines accompanied by repeated rehearsal and practice, initially in a rote fashion and gradually moving toward variations of the initial practice situations’ (p. 354). In other words, the newly learned skill or behaviour should be practised in a safe and comfortable setting (e.g. school or home) before testing it out in different contexts in the real world in the hope of promoting generalization.

In summary, by drawing on the various strengths of both the behavioural and cognitive approaches to teaching social skills, it is possible to outline the key elements which should be included in any new social skills teaching package. Ideally, the package should allow for the following:

- repetition of the target skill or task;
- rote learning of social rules;
- fading of prompts over time;
- verbal instruction/explanation of the social skill;
- a consideration of how one’s own behaviour impacts on others (i.e. understanding other minds);
- practice of skills in realistic settings;
- the ability to practise the skill across contexts;
- role-play of target behaviours;
- accessibility and ease of use for schools and teachers; and
- affordability for home and school environments.
Moving beyond a rule-based approach

Controversy surrounds the processes of typical development in social understanding. Some accounts posit that children acquire rules and principles for working out what people think (e.g. Wimmer et al. 1988; Perner 1991; Gopnik 1993). These accounts imply that teaching rules to people with autism should be sufficient to equip them with an understanding of the mind. However, competing accounts posit that we understand other minds not by applying rules, but by imaginatively adopting other people’s conceptual perspectives (e.g. Harris 1991; Gordon 1995). In other words, we use our imagination to set aside the world as we see and know it, and then mentally simulate a counterfactual state that can then be projected onto another person as their belief. The developmental grounding of a capacity for mental simulation could be in early pretence (Harris & Kavanaugh 1993), where children have an opportunity to practise what it is like to be other people and for imagining the world to be a different kind of place, i.e. pretence gives an opportunity for role-play, which is probably an essential ingredient in the mental simulation of other minds. Note that nobody teaches children how to pretend; rather, they gain insight into other minds as a consequence of the spontaneous activity of pretence.

Children with autism have little aptitude for pretence (e.g. Lewis & Boucher 1988), thus denying them an opportunity to role-play, with the knock-on effect that they have little prospect of being able to understand other minds through mental simulation. A way to compensate for this deficiency would be to help children with autism make judgements about mental states by applying rules, and as we have already seen, this can yield limited success. However, identifying a vehicle for promoting role-play might engender even greater success, especially if it nurtures a capacity for mental simulation. In short, people with autism might be impaired in their understanding of the mind because their capacity for pretence is disrupted where this denies them opportunities for role-play. So long as opportunities for role-play via other routes can be created, this would perhaps offer the best chance for people with autism to develop insight into the mind.

Virtual reality: New potential for social skills training?

This section outlines the nature of virtual environments (VEs) and their use in the field of cognitive rehabilitation, and considers how VEs could potentially encompass all of the successful features of behavioural and cognitive paradigms in one package, including the opportunity for computer-mediated role-play.

Virtual environments allow users to interact with a three-dimensional computer-based world incorporating impressive graphics and design. Users can move through a VE in real time using a joystick or mouse. They can interact with objects in the scene and are typically represented as a humanoid ‘avatar’. Thus, VEs can look realistic, and can include representations of people as well as objects. The growing sophistication of such applications has led to their successful use in various fields of cognitive rehabilitation, such as attenuating vertigo and flying phobia (Rothbaum & Hodges 1999), and helping children with learning disabilities to develop everyday skills; for example, catching the right bus and buying food in a supermarket (Brown et al. 1999). Indeed, VR applications are currently being used for many different populations, including people with spinal cord injury (Riva 2000), and children with visual impairments (Sanchez & Lumbreras 2000).

There has been considerable discussion about the relative merits of VR technology (VRT) in the fields of education and rehabilitation for different clinical groups (e.g. Editorial 1991; Andreac 1996; Cromby et al. 1996; Wilson et al. 1997, 1998; Jones 1998; Myers & Laenger 1998; Ring 1998; Scherer 1998). Most discussions tend to concentrate on motor disabilities, severe physical handicaps or more general learning disabilities. One benefit is that people with limited mobility can engage in activities in virtual space which they would not normally be able to participate in. Some ethical concerns surround the use of fully immersive VRT (i.e. the use of head-mounted displays). Head-mounted displays can be extremely expensive and people may experience ‘cybersickness’ in the form of nausea, headaches and dizziness (Cobb et al. 1999). Desktop VEs [those shown on a standard personal computer (PC), where navigation is achieved with a joystick]
tend to be much less susceptible to the problems of cybersickness (Nichols 1999). Moreover, because the software can be used on standard PCs, desktop VEs represent a more accessible and affordable approach. Indeed, a recent project at the University of Nottingham, Nottingham, UK, developed a virtual physics lab in which secondary school pupils could complete experiments which they would not be able to run in the real world; for example, those involving radioactive materials. The virtual lab (RADLAB) was widely distributed as a CD-ROM to all secondary schools in the local education authority (Crosier et al. 2002). Another concern is that target populations are not usually included in the development of an application (Korpela 1998). This may lead to applications which are not optimal for the target group. User-centred design methodologies (e.g. Brown et al. 1999) address this concern somewhat because representative users are included in product design and development from the start.

The potential usefulness of VRT for the autistic population is already being recognized. Various authors have noted the possible benefits of virtual environments for people with ASDs (e.g. Clancy 1996; Trepagnier 1999). More specifically, one advantage of VRT is that the need for ‘real world’ social interaction is minimized, thus reducing this source of anxiety for people with autism (Moore 1998; Moore et al. 2000). It is important to stress that the idea is not for the VE to minimize social interaction per se, but rather, to allow the safe and non-threatening practice of particular skills in an educational setting.

There is concern that providing a safe, non-social environment on the computer somehow ‘colludes’ with the social disability of autism. For example, Howlin (1998) suggested that an over-reliance on computer interaction could lead to obsessive behaviour and a decline in real-world interaction. Latash (1998) also commented that ‘...VR may become too safe and too attractive so that the patient can become a computer addict and be reluctant to re-enter the real world’ (p. 105). Whilst this is an important issue, there are two main reasons why these worries may be unfounded.

First, it is likely that the main cause of obsessive behaviour in relation to computer use is the predictability of programming, i.e. the child finds the interaction appealing because they are in control and know exactly what is going to happen next. The incorporation of more flexible, unpredictable events in VEs might go some way to overcome this problem (see below). The child would not be able to use the computer in a passive way, but would need to think about the required response in order to proceed further. Consequently, the child’s interaction with the computer would be more active, less predictable, and therefore, less obsessional.

Secondly, a VE for social skills training would best be used in collaboration with other people. The aim is not to circumvent real-world social interaction altogether, but to provide a teaching aid that would allow practice and demonstration alongside normal input from a teacher or support worker. Thus, real-world social interaction can be incorporated by the presence of teachers and parents sitting alongside the person with autism (Murray 1997), as in the use of different desktop virtual environments (Neale et al. 1999). There is certainly some encouraging evidence from normal development to suggest that interaction with another person during the use of computer-based tasks significantly improves learning outcomes. For example, Mevarech et al. (1991) found that, when children worked in pairs on computer-based tasks, they were significantly more likely to demonstrate improvements in learning compared to children who worked individually.

This collaborative set-up would ensure that instructors provide verbal explanations of the target social skills as the user worked through the programme. The inclusion of tangible representations of mental states (e.g. thought bubbles) could facilitate this process by allowing users to consider other people’s mental states directly. Encouraging evidence indicates that thought bubbles can help children with autism pass false belief tasks (Parsons & Mitchell 1999), and also help adults with AS to consider the implications of thought during conversation (Rajendran & Mitchell 2000). Allowing users to see thoughts directly could help when trying to consider how the user’s own behaviour could be perceived by others in the environment.

The computer environment offers additional advantages. It is stable, familiar and predictable,
and can be adapted to suit individual needs (Swettenham 1996). The amount, type and level of particular inputs (e.g. visual, auditory) can also be controlled directly, allowing basic skills and tasks to be completed in the absence of competing and distracting cues (Wilson et al. 1998). Perhaps the most important advantage of a VE, though, over and above the benefits of normal computer-based tasks, is that the user can role-play in an environment designed to simulate real-world scenarios. Thus, responses can be practised in realistic settings in the absence of potentially threatening and frightening real-world consequences. This is of particular importance because it means that responses to different scenarios can be practised before, during or after being taught. The computer-mediated role-play might present a vital opportunity for individuals to experience different perspectives, which, in turn, might nurture more general skills in mental simulation. Perhaps it could go some way to substitute for the lack of role-play experience that stems from the autistic impairment in pretence.

A further benefit of computer-based learning is that tasks can be repeatedly presented and practised in a consistent way without the fatigue sometimes associated with task repetition by human instructors (Cromby et al. 1996). The ease of repetition of the task could facilitate the rote learning of social rules in a specific context before moving on to allow practice of the skill in a different context. The possibility of developing different VEs designed to mimic a variety of social situations is a particular strength of this approach. In addition, different types of scenario could increase in complexity as the user becomes practised at, and familiar with, a particular type of task. For example, a café environment – in which the user has to order some food and find a place to sit down – could start off with lots of empty seats, but become increasingly populated and busy as the user moves through the programme. A bus scenario could work in a similar way, with increasingly fewer choices of empty seats. An increase in complexity could also work alongside a prompt-fading sequence, in which the user is initially provided with numerous prompts when beginning the task on a more difficult level, before the prompts fade gradually over time. Text boxes, verbal instructions and flashing red areas of interaction (e.g. the lock on a bathroom door) have been used very successfully as prompts in previous training packages for people with learning disabilities (Brown et al. 1999).

The possibility of scenarios differing slightly each time that the user encounters them could promote a more flexible style of responding. For example, behaviour demonstrated on a previous occasion (e.g. walking to a particular point at the bar to order a drink) may need to be changed slightly on a subsequent trial because of a small change in the environment (the same route to the bar cannot be taken because people are standing in the way). Thus, the user has to think of different ways of solving the same problem. As noted above, this aspect of the programming could help to guard against an obsessional use of the package and an over-reliance on the technology (cf. Howlin 1998). This hierarchical approach to developing social skills within a specific environment could then be repeated in a new environment, ensuring that the same skill could be practised across different contexts.

This aspect of task presentation could improve the chances of generalizing skills across contexts. In addition, the inherent properties of VEs may facilitate the crucial transfer of understanding from the virtual to the real world because of the shared features between virtual and real environments, in the form of realistic images and scenarios. Transfer of knowledge to the real world can occur after prior training with VEs, at least amongst able-bodied adults and children with disabilities (Wilson et al. 1996, 1997; Stanton et al. 2000), and for people practising a simple sensorimotor task (Rose et al. 2000). It remains to be seen whether successful transfer can be achieved in the realm of social skills training for people with ASDs.

Generally, there seem to be good reasons for thinking that VEs might be particularly useful for people with ASDs in the context of a social skills training programme. Perhaps most crucially, though, the promotion of both intra- and intercontext flexibility within a VE training package may allow us to tackle a very specific impairment in cognitive functioning common to many people with ASDs: cognitive flexibility. The following section summarizes some research on cognitive flexibility in people with ASDs and then examines the usefulness of VEs for addressing this particular ability.

Cognitive flexibility, autism and virtual environments

Cognitive flexibility is an executive function that requires frequent shifting from one response pattern to another. ‘Executive function’ is an umbrella term covering many cognitive abilities such as interference control, inhibition, integration across space and time, set-shifting and set maintenance, planning, and working memory (Pennington & Ozonoff 1996). People with autism have shown consistent deficits in executive function tasks (e.g. Hughes & Russell 1993; Hughes et al. 1994; Ozonoff 1995), although it is important to note that participants do not seem impaired across all aspects of executive function. Ozonoff & Strayer (1997) reported that people with HFA were not impaired in their ability to inhibit responses to stimuli. The same finding in a different group of participants with HFA was reported in Ozonoff et al. (1994). Perhaps most importantly, Ozonoff et al. (1994) also reported that, whilst people with HFA were not impaired in their inhibition of responses, they were significantly impaired in their cognitive flexibility relative to control groups. Cognitive flexibility also seems to be predictive of social skills development. Berger et al. (1993) reported that 17 adolescents with HFA were given a number of assessments, including social comprehension tests and a test of cognitive flexibility (or ‘shifting’; the Wisconsin Card Sort Test, WCST; Heaton 1981). After 2 years, their social understanding was measured again and cognitive shifting was the only significant predictor of improvements in social understanding. There was a negligible and non-significant relationship between intelligence and progress in social understanding.

This impairment in flexibility could be crucial in explaining why social situations are so difficult for people with autism. Every social situation is unique, and therefore, requires flexibility of responding according to the nuances of the situation. There is a marked lack of social reciprocity in autistic social interactions. This is evident in difficulties initiating and sustaining conversations (Howlin 1997), impairments in initiating and maintaining eye-contact (Mundy et al. 1994), and often, a failure to use gaze direction as a source of information about the communicative intention of a speaker (Baron-Cohen et al. 1997). Speakers may engage in long monologues about esoteric topics without allowing input from a listener, and seemingly without any consideration of the listener’s level of interest or knowledge state. In short, thinking seems to be rigid, with a difficulty in switching attention between objects, people or topics of interest (Pennington & Ozonoff 1996).

The requirement for flexibility in social situations is where the rule-based ToM approach to teaching social skills may falter. Indeed, Berger et al. (1993) suggested that impairments in cognitive shifting may be particularly difficult to overcome because ‘...self-initiated flexibility... can hardly be taught explicitly by means of highly structured educational programs’ (p. 356). One of the specific benefits of VEs is that they allow rules for responding to be taught in one context, and also allow the practice and role-play of behaviours across different contexts. In this way, flexibility can be encouraged by providing role-play situations in which the learned rule may not apply every time. It is possible that practising flexible responding in a safe and controlled environment might reduce anxiety in people with ASDs, enabling them to plan what to do next, rather than displaying repetitive, stereotyped behaviours, which may not be helpful in achieving their goal. Additionally, the role-play might itself promote development in mental simulation abilities, which is an approach to understanding mental states that is inherently very much more flexible than a rule-bound approach (Mitchell et al. 1996; Hulme et al. 2001).

Importantly, some evidence suggests that general impairments in cognitive flexibility can be attenuated by computer-based presentation of tasks. Pascualvaca et al. (1998) reported that children with autism performed as well as controls on a computerized version of the WCST, but significantly worse than controls on the standard, non-computerized version. The authors suggested that social/motivational factors could be responsible for the effect, i.e. children with autism might prefer to receive feedback about their performance from a computer rather than the examiner. This preference could lead to reduced motivation on tasks where feedback is only available from a human examiner. Ozonoff (1995) echoed this interpretation when discussing a similar pattern of results amongst her group of children with autism. Using a different clinical popula-
tion (adults with traumatic brain injury), Chen et al. (1997) also reported significant improvements in their treatment group over time on a computerized version of the WCST (as well as other cognitive tests). Overall, these findings suggest that computer presentation of set-shifting tasks can lead to reduced impairment on this measure relative to non-computer-based tasks as well as improvements in flexibility over time.

Conclusions

Overall, there seems to be an encouraging basis from which to develop a new approach to social skills training for people with autism. Virtual reality technology is an exciting tool that can accommodate the strengths of previous social skills intervention strategies, and also extend the possibilities for learning by allowing flexible responding to be practiced in a safe and supportive environment. In addition, VEs may facilitate the transfer of knowledge between the virtual and the real world, a crucial consideration in any attempt to teach social skills.

Concerns that the use of computer-based technology might collude with the social disability of autism, rather than improve social understanding, are assuaged somewhat by the adoption of collaborative working practices (i.e. a teacher/parent/carer sitting alongside the person using the program) and built-in flexibility that ensures that programs remain unpredictable. In other words, VEs should be used to augment teaching practices rather than replace them.

The proliferation of new technologies is exciting because of the opportunities which they offer to different clinical groups in need of very specific kinds of help. Whilst the use of VR is not promoted as a panacea for these problems it does, nevertheless, provide a novel approach to social skills training for people with autism. Over and above the appeal of novelty, VRT allows us to target the specific realm of cognitive flexibility – an area of functioning which may not be amenable to investigation by more traditional approaches, such as story-telling and the presentation of pictures or photographs. Virtual reality technology might also offer a valuable opportunity to practise role-playing skills, which could have both practical and cognitive benefits. Only by exploring new ways of tackling the problem of social skills training for people with autism can we hope to gain further insights into what might be possible for intervention and training purposes. Virtual reality technology provides a unique viewpoint on this issue and should be welcomed, albeit with careful consideration.

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References


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