*Journal of Computer Assisted Learning* (2003) **19**, 546-556

# *The Internet for educating individuals with social impairments*

*J. Bishop*
School of Computing, University of Glamorgan

**Abstract** Social impairments materialise in a number of forms, from developmental disabilities such as autistic spectrum disorder, to psychiatric conditions such as social phobia. The individuals diagnosed with these problems find it difficult to deal with social situations through either the inability to perform in these situations or the fear of not being able to do so. The study investigated the social and practical implications of using Mobile Internet technology to deliver information relating to a social situation in real-time to participants with Autistic Spectrum Disorders (*n = 10*) and General Social Phobia (*n = 3*) diagnosed using DSM-IV. The participants used the agent on their mobile phone to convert phrases they found offensive or confusing into more concise and understandable definitions. Analysing their attitudes revealed that the technology enables socially impaired individuals to learn the meaning of emotions and understand more about how they communicate with their peers. However, the study concludes that governmental organisations, education providers and society as a whole need to adopt a cohesive approach to communication to ensure socially impaired individuals are fully included in society

**Keywords:** Autism; Collaboration; Emotion recognition; Social phobia; Special education; Wireless agents

## Introduction

The ability to communicate thoughts and ideas has never been more important than in the 21st century, where mediated communication is increasing in use and success in the workplace is often restricted by insufficient social skills. This problem is greater than ever for individuals diagnosed with social impairments such as Autistic Spectrum Disorder (ASD) and general social phobia (GSP) who are often unable to competently participate in social environments.

### *Interpretation of idioms*

The individual with Autistic Spectrum Disorder tends to have a literal interpretation of what people say to them (Attwood, 2000; 76–78). For example, they may interpret the statement 'I could die for a cup of tea' as an extreme thing for someone to do to quench their thirst. This can cause great difficulties in social situations

Accepted 19 March 2003

Correspondence: Jonathan Bishop, School of Computing, University of Glamorgan, Llantwit Road, Pontypridd, Wales, CF37 1DL Email: jonathan@jonathanbishop.com

 

where such idioms are frequently used, making the individual feel stupid and socially inadequate.

A related difficulty for individuals with ASD is an inability to adequately respond to closed-ended questions or statements. They may interpret a comment such as 'it's nice weather today' as a statement of fact and not as an invitation to engage in casual conversation. In such situations, the individual usually responds with single-word answers and may even disagree with the statement without understanding that this could be offensive.

The individual with general social phobia is usually able to understand the context of idioms, but is likely to interpret these comments in negative manner (Clark & McManus, 2002). For example, they may interpret the question, 'where have you been?' as an intrusive means of scrutinising their behaviour as opposed to the person being interested in them. These misunderstandings can lead to communication apprehension where the individual will avoid situations that require a significant amount of social interaction. Students in school with GSP are more likely to abandon their studies, less likely to participate in group study and social gatherings, and are unlikely to attend higher education at a later stage. Communication apprehension is a significant factor in the dropout rates, with as many as 25% of students with GSP citing this as the reason for leaving school prematurely (Van Ameringen *et al*., 2002).

*Interpretation of emotions*

In human-to-human communication, emotions are communicated mainly through facial expressions, bodily gestures and the tone in which something is said. Individuals with social impairments can feel excluded from social situations through the inability to recognise, interpret or respond to these various affects.

A study by Klin *et al*. (2002) found that individuals with Autistic Spectrum Disorder focus twice as much attention on the mouths and bodies of people as on eyes in social situations. The study also found that when those with ASD concentrated on the eyes of others they were not able to interpret the affect being communicated and those who concentrate on the mouth did so as a way of coping when others express idioms or irony in which the verbal and non-verbal messages are contradicting.

Individuals with general social phobia are able to recognise and respond to emotions, but they may interpret these negatively or avoid eye contact all together. Horley *et al*., (2001) found that subjects with GSP developed a 'hyperscanning' strategy for processing faces, which is characterised by a lack of fixations, particularly of negative expressions.

*Role-play and peer groups*

Educators often put a strong emphasis on role-play to attempt to make their subject seem as realistic as possible, but individuals with ASD may find assignment briefings that require pretence confusing or offensive if these are not prepared carefully (Frith, 1991). For example, if an examination question read, 'You are a software engineer, write a short program to display the text "Hello World" in a blue font' the student with ASD might feel horrified and offended at the proposition of being a software engineer, something which would not been seen as a detrimental statement to the educator. Students with GSP also find examinations distressing and

tend to experience a significant amount of underachievement in environments where scrutiny of their performance is likely. These students have great difficulty speaking in front of a class, which is often a core part of the teaching process in secondary and higher education and may stay away from school for extended periods in order to avoid such situations (Van Ameringen *et al*., 2002).

Group activities can be particularly stressful for students with ASD, who are predominately individuals as opposed to natural team members (Attwood, 2000). For example, an activity that requires the individual to work in an unstructured manner may seem an appropriate way of testing the students' organisational skills to the educator, but the student with ASD may feel frustrated at having to do something they believe they could accomplish quicker or more accurately alone.

## Diagnosis and treatment

Often, the only way a socially impaired individual can obtain help and support is through seeking a medical diagnosis from their physician. This convention of using the medical model of disability to classify people and then treat the symptoms of the impairment as opposed to making changes in social structure is in most cases accepted as the norm. Diagnosis is often the first step in a long struggle for individuals with social impairments as illustrated in a study conducted by the National Autistic Society (Barnard *et al*., 2000), which found that children diagnosed with ASD are on average 20times more likely to be excluded from school than their peers.

Social impairments are most often diagnosed using the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) (APA, 1996). Van Ameringen and colleagues emphasised the importance of diagnosing and treating social impairments in children and adolescents to ensure that as many youth as possible have the opportunity to enjoy education at all levels and become full participants and contributors to society.

Autistic Spectrum Disorder is diagnosed using DSM-IV when the individual is found to have '*qualitative impairments in social interaction and communication*', '*restricted repetitive and stereotyped patterns of behaviour, interests and activities*', and where they show abnormal functioning before 36 months in '*social interaction, use of language, or symbolic and imaginative play*.' Social phobia is described using DSM-IV as '*marked and persistent fear of one or more social or performance situations in which the person is exposed to unfamiliar people or to possible scrutiny by others. The individual fears that he or she will act in a way that will be humiliating or embarrassing.*'

### *Social Skills Training*

Social Skills Training (SST) can be an effective means of reducing social and general anxiety and increasing social skills and self-control amongst socially impaired individuals. SST is usually undertaken through a local healthcare provider and involves behaviour modelling and rehearsal, successive approximation and home-based assignments (Van Dam-Baggan & Kraaimaat, 2000).

Despite increased interest in finding technological means to provide social skills training to individuals with ASD, little attention has been given to providing SST to individuals with general social phobia since the publication of DSM-III. Van Dam-Baggan & Kraaimaat (2000) suggested that this might be because it is hypothesised

that those with GSP have the necessary social skills to interact in social situations, but are inhibited by anxiety. Indeed, the study also indicated that individuals diagnosed with GSP develop social deficits because of a long history of lack of socialising experiences. Again, as with social skills training for ASD, any attempt to find a technological solution for assisting individuals with GSP should not play to the social impairment aspect of the disability that prevents individuals from engaging in social situations.

*Medical treatment*

Medical treatment is usually only conducted when the socially impaired individual is unable to overcome their disability through social skills training.

*Dietary intervention.* Fairbrother (2002) highlights that through making changes to their diet and hygiene, socially impaired individuals are often more able to overcome their disability. She draws attention to the suggestion that by engaging in regular physical exercise, behaving as if they feel confident even if they are not, practice maintaining good posture, holding their head up, speaking at a normal volume, and using decisive and confident gestures, individuals with social impairments are able to overcome their natural tendency to do the opposite. Indeed, a study by Blades (2000) into the affect of change of diet on children diagnosed with ASD found that inclusion of a probiotic in a child's diet decreased the symptoms of ASD, including the need for strict routines.

*Anticonvulsant medication.* A number of studies have investigated the role of anticonvulsant medication in treating socially impaired individuals. However, Di Martino & Tuchman, (2001) stress that there is only anecdotal evidence to suggest that there is a beneficial role for anticonvulsants in children with ASD. There not presently any evidence to support the hypothesis that there is a subgroup of children with ASD, epilepsy and affective disorders that respond preferentially to anticonvulsant drugs. The role of affective anticonvulsants in children with ASD with or without seizures is not established.

*Antidepressant medication.* A study by Schneier (2001) suggests that antidepressants can be effective in reducing anxiety, avoidance of feared situations and improving social functioning of individuals with social impairments. He suggests that antidepressants have the advantage of a more rapid onset of effect than psychotherapy alone, typically taking effect within 4–8 weeks. However, Keller (2001) indicates that little research has been conducted into the role of antidepressants in alleviating social impairment and that it is not known whether such drugs act directly to affect mechanisms that mediate social functioning, or via clinical improvement of depression.

*Limitations of the medical model of disability*

The medical model of disability has come under a significant attack from academics in the last 30 years who have suggested that it is society that disables impaired individuals and that disability is something imposed on top of such impairments by the way disabled people are isolated and excluded from full participation in society (Oliver, 1983). The diagnosis and treatment approach of the medical model of disability is very limited in helping socially impaired individuals understand themselves and colleagues so that they can fully participate in society. Oliver

advocates a 'social model' approach to understanding disability, which suggests that society is excluding socially impaired individuals and not the impairment itself. However, having their impairment classed as a medical condition is often the only way socially impaired individuals can attempt to acquire the support they need from employers, educators and governmental organisations.

## Towards an inclusive solution

The medical model puts the responsibility on the socially impaired individual to seek treatment and adapt to their environment through developing coping strategies, meaning the socially impaired individual is treated in the same way as their peer group with no concessions made to take into account the difficulties they face.

Frith (1991) questions this approach in individuals with ASD, indicating that in the workplace, nondisclosure of their impairment to employers can lead to employees with ASD losing their jobs. For example, a change in working hours may seem like an acceptable proposal to the employer, but a lack of understanding or knowledge of the impairment may make such a request for change in routine seem completely unacceptable to an employee with ASD.

Individuals with GSP may fear ridicule in social situations and may avoid situations in which they feel vulnerable. An individual with GSP could misconstrue a remark that their peers would consider humorous as a personal attack and would try to avoid situations in which this could occur. If put in to practice, the social model of disability would mean that the peers of individuals with GSP would take extra care to structure their sentences so that they would not be misinterpreted in a negative manner. A paradox emerges in the case of individuals with ASD as they often make comments that they deem to be humorous, whereas their peers may interpret their comments to be offensive.

### *Developments in UK social inclusion policy*

In the past decade, there have been a significant number of policy initiatives aimed at disabled individuals, from employment rights to access to goods and services (Burchardt, 2000). The Disability Discrimination Act (1995) (DDA) introduced by the UK Government gave these policies statutory recognition making it an offence to unfairly discriminate against individuals with an impairment. The Special Educational Needs & Disability Act 2001 (SENDA) extended the DDA to education establishments making it a requirement for them to make the appropriate adjustments to allow individuals with impairments to access all educational services made available to individuals without impairments.

## Virtual learning environments

The use of virtual learning environments (VLEs) for the purpose of social skills training remains relatively unexplored (Moore, 2000). VLEs are possibly suited to social impaired individuals as they allow them to learn at their own pace in a secluded setting. Recent developments in Desktop VLEs, such as the MindReading software (Cambridge Learning, 2002) have made it possible for individuals with ASD to learn the meaning of emotions using interactive multimedia techniques.

However, Parsons & Mitchell (2002) point out that although VLEs provide a safe environment in which social skills can be taught, the nonsocial environment of

such application may collude with the social impairment of individuals with ASD, making them more unwilling to participate in less manageable social environments. Indeed, Parsons & Mitchell recommend that VLEs should only be used in collaboration with other people and not to circumvent real–world social interaction altogether, suggesting that the training should be conducted alongside normal input from a teacher or parent.

Social environments are particularly distressing for individuals with ASD as they are not always able to respond in the appropriate manner because such situations require a cognitive flexibility to deal with the uniqueness of the moment (Berger *et al*., 1993). In order to make sense of the social skills training presented in scenario-based VLEs, individuals with ASD may develop rules to attempt to interpret what is being presented on their PC in order to deal with them when they occur in future situations. The rules-based approach taken by individuals with ASD is quite understandable, as it is the same process required to program a VLE to teach the social skills through scenarios in the first instance. MindReading (Cambridge Learning, 2002) uses scenarios to a limited degree, but is more flexible in that it concentrates mainly on teaching the meaning of facial expressions and prosody and not only the situations in which they may occur.

*The use of assistive technology*

Lupton & Seymour (2000) argue that technology offers the potential to assist individuals with physical disabilities by augmenting or substituting particular bodily functions, thus making it possible for them to participate in previously inaccessible activities and domains. However, French (1991) suggests that assistive technology can become a burden because others will see the impaired individual as self-sufficient believing their disability to be removed by the technology. French points out that visual aids will not make someone who is visually impaired sighted, as they will continue to be dependent on the technology to overcome their impairment and still require support for some activities.

## Portable Affect Reference Learning Environment

Individuals with social impairments who undertake social skills training are often more able to cope with their disability through learning the techniques required to effectively participate in social situations. The author proposes a collaborative learning approach to social skills training using Internet-based technology. Collaborative learning is an approach based on constructivist principals that suggests that learning is a social process and that it should promote reflection, development of communication skills, a broader scope and a greater exposure to different opinions and ideas (Weller, 2002: 48). Such a learning environment has the potential to address the difficulties faced by individuals with social impairments, as it specifically requires the individuals to work within their peer group.

*Technology issues*

The Portable Affect Recognition Learning Environment (PARLE) would use semantic querying of a computer database via an Internet-based mobile phone in real-time during social situations to translate idioms, aphorisms and common phrases into more meaningful expressions along with explanations and suggested responses. For example, if during a conversation the individual with a social

impairment was asked, 'cat got your tongue?' this would be translated into an open-ended question such as, 'you appear quiet, how come?' This translation would make more sense to a person with ASD who may have interpreted the original statement literally, and an individual with GSP would be less likely to construe it as a rhetorical question.

To operate, PARLE requires third generation (3G) mobile Internet technology with the capabilities to allow simultaneous recording of sound and video. Using such hardware with a mobile educational agent would allow real-time interpretations of conversations to be delivered to the socially impaired individual (Fig. 1).

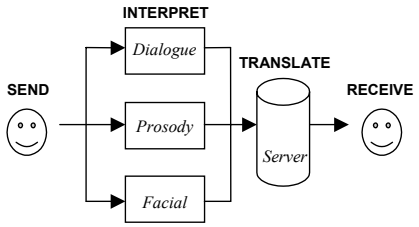


**Fig. 1.** Processes of the PARLE System

The automatic analysis of prosody and facial patterns is particularly relevant to individuals with ASD, as they will often interpret the context of the dialogue of a conversation literally and not take into account voice tone or facial expressions of the person with whom they are communicating.

*Mobile Educational Agent.* An educational agent is a form of computational support, which enriches the social context in a social learning environment either by providing virtual participants to enhance the member multiplicity of communities or by supporting facilities to foster communication among real participants (Chou *et al.*, 2003). The mobile platform well suited to this type of agent as its robust and fault-tolerant architecture means that it is able to overcome network latency problems that can occur with network-intensive agents (Lange & Oshima, 1999).

The reliability of affect recognition algorithms to interpret the emotions held in the structures of faces and patterns of speech are fundamental in order for the mobile educational agent to be effective. There has been a significant amount of research into facial affect recognition (FAR) and speech affect recognition (SAR), investigating both the technical and practical aspects of implementing emotion recognition agents (ERAs) on desktop platforms. Facial expressions are generated by contractions of facial muscles, which results in temporally deformed facial features such as eye lids, eye brows, nose, lips and skin texture, often revealed by wrinkles and bulges. Fasel & Luettin, 2003) found that the current FAR agents are restricted due to the robustness of these systems and the constraints posed the subject and recording conditions. Most of the FAR agents investigated required manual intervention for the interpretation of the facial feature points to be accurate, making video recording sequences difficult to interpret in real-time.

Although there are still a lot of issues that need to be addressed in relation to FAR agents, there has been a greater degree of reliability in the application of SAR agents. A study by Petrushin (2000) investigated the potential of a SAR agent for distinguishing between 'calm' and 'agitated' emotional states of callers to a telephone support centre. The system delivered 77% accuracy and proved effective for prioritising of voice messages and assigning the appropriate human agent to the caller. Petrushin suggested the SAR agent is flexible enough to be built into virtual environments, tutoring systems and has the potential to assist individuals with ASD in developing emotional skills and the ability to recognise emotion in speech.

## Feasibility of PARLE

As the technology to implement the PARLE system fully was not available, a study using an Internet-enabled mobile phone based on the Wireless Application Protocol (WAP) was conducted to assess the 'dialogue translation' functionality. Unlike the 3G mobile phones that use multimedia technologies, WAP limits the user to sending only text to Internet servers by typing it in via a keypad and therefore the 'prosody' and 'facial' translation functionality could not be tested.

*Methodology*

A database of idioms and phrases was constructed and linked to the Internet using server-side programming techniques. The participants, made up of individuals diagnosed with ASD ($n = 10$) and GSP ($n = 3$) were presented with two stories and asked to enter the phrases and sentences they found confusing or offensive into the PARLE system. Participants were then asked to complete a survey to assess their attitudes ($A$) toward the PARLE system. The survey was conducted using a multi-attribute design based on the Attitude-Toward-The-Object-Model (Fishbein & Ajzen, 1980). The results are presented in Table 1.

*Findings*

The participants with ASD reported the strongest attitudes towards the PARLE system, finding it useful, easy to use and efficient. The participants with GSP had a slightly negative attitude towards the functionality of the system, finding it not very useful, not very easy to use and not very efficient. The participants with GSP also reported that they felt the system met their expectations, suggesting that they did not have a positive opinion of the system before using it. The participants with ASD felt that the PARLE system exceeded their expectations and made them feel good about themselves after using it, indicating that they were more able to understand the stories after using the system. The participants with GSP also indicated that they were more able to understand the stories, but felt the system did not make them feel any better. The participants with GSP showed a strong discomfort with using PARLE in social situations, with a particularly strong attitude against using it at home. In contrast, the participants with ASD were keen on using PARLE in both a home setting and during a social situation in public.

**Table 1.** Mean averages of attitudes (A) towards the PARLE System

| Attitude | ASD | | GSP | |
|---|---|---|---|---|
| How useful did you find PARLE? | 0.80 | (A = 4.80) | – 0.33 | (A = – 1.00) |
| How easy to use did you find PARLE? | 1.10 | (A = 7.70) | – 1.00 | (A = – 3.00) |
| How efficient did you find PARLE? | 1.00 | (A = 6.20) | – 0.67 | (A = 0.67) |
| How good did using PARLE make you feel about yourself? | 1.50 | (A = 10.90) | – 1.00 | (A = – 1.00) |
| How much did PARLE meet your expectations? | 2.30 | (A = 15.30) | 1.33 | (A = 8.00) |
| How able were you to understand the stories after using PARLE? | 0.70 | (A = 1.90) | 0.33 | (A = 1.67) |
| How likely would you be to use PARLE in a social situation in a public place? | – 0.20 | (A = 2.60) | – 2.33 | (A = – 3.00) |
| How likely would you be to use PARLE in a social situation at home? | 0.60 | (A = 8.60) | – 1.67 | (A = – 5.00) |

Although the results of the study demonstrated that there is a demand for PARLE from individuals with ASD, the functionality of the system would have to be adapted to meet the needs of those with GSP. The negative attitude of individuals

with GSP toward the usefulness of the system could have been because they have less of a problem in interpreting the literal meaning of what is said to them in a social situation, but are more likely to interpret a comment in a negative manner. As the nonverbal emotion recognition aspects of PARLE could not be tested, it is possible that individuals with GSP were less likely to benefit from the translations, which only explained the meaning of the idioms and not the manner in which they were used.

The practical application of the system in a nonmediated social environment could generate further difficulties for the socially impaired users. In order for the user to receive information in text-form via the mobile phone display, they would have to lose eye contact with the person they are trying to communicate with, which amplifies the symptoms of the social impairment, particularly in individuals with ASD or GSP. A possible solution to this anomaly would be to provide the feedback via an earpiece so that user is able to learn to read the affects of their peers in real-time. This approach also has limitations as the use of an earpiece could create a feeling of ignorance or suspicion in the mind of peers, which could cause the system to interpret the conversation as negative, creating further anxiety for the socially impaired individual.

Even if the limitations of PARLE were overcome, it could not be considered a stand-alone solution to the problems faced by socially impaired individuals in daily situations. A lack of understanding of the needs of individuals with ASD or GSP excludes them from full participation in society and assistive technology can only help the individual to a limited degree. Indeed, Roulstone, 1993) suggests that the most disturbing element of impaired technology-users is that although impaired individuals themselves realise the particular benefits that technology has for them, their peers may be oblivious to these benefits.

## Discussion

Individuals with social impairments, such as Autistic Spectrum Disorder and General Social Phobia face communication difficulties in daily situations, ranging from an inability to interpret phrases and facial expressions to being unable to interact competently with peer groups can make the lives of these individuals difficult and demanding.

Current understanding of social impairments has been based on a diagnostic and treatment process that assumes that socially impaired individuals are suffering from an abnormality that can be alleviated through medical treatment. This process overlooks the genuine role society can play in assisting socially impaired individuals through adopting a more inclusive approach and providing these individuals with the opportunity to learn how to understand the world around them.

Assistive technology offers socially impaired individuals an environment in which they can learn the meaning of emotions and understand more about they way they communicate with their peers. Both the text and audio-based solutions to providing socially impaired individuals with the information could create cognitive difficulties because additional information processing is required to participate in a social situation. However, the self-focused attention (SFA) and task-focused attention (TFA) behaviours that are commonly associated with socially impaired individuals could be alleviated if they are required to concentrate on what their peers are saying as opposed to attempting to decide how they should to respond or

calculating whether their peers are developing negative opinions about them. Although SFA or TFA are not detrimental to socially impaired individuals, there is a significant correlation between those who focus their attention on themselves or the task of conversing and symptoms of social anxiety (Bögels & Lamers, 2001).

The practical application of systems such as PARLE may lead those around socially impaired individuals to believe that they have been 'cured' and that their needs are being fully met. This would result in individuals with ASD and GSP remaining disabled from full participation in society. If the social model of disability is to be made to work for socially impaired individuals then employers, education providers, governmental organisations and society as a whole need to adopt a cohesive approach to communication and the way in which social environments, services and information documents are devised and implemented. The outcome of such a strategy would not only benefit socially impaired individuals, but all communities through the creation of a culture of clarity and tolerance.

## References

APA (1996) *Diagnostic and Statistical Manual of Mental Disorders- Fourth Edition.* p. 7. American Psychiatric Publishing, Arlington, VA.

Attwood, T. (2000) *Asperger's Syndrome: A Guide for Parents and Professionals*. Jessica Kingsley Publishing, London.

Barnard, J., Prior, A. & Potter, D. (2000) *Inclusion and autism: is it working?* National Autistic Society, London.

Berger, H.J.C., van Spaemdonck, K.P.M., Horstink, M.W.I.M., Buvtenhuiijs, E.L., Lammers, P.W.J.M. & Cools, A.R. (1993) Cognitive shifting as a predictor of progress in social understanding in high-functioning adolescents with autism. *Journal of Autism and Developmental Disorders*, **23,** 341–359.

Blades, M. (2000) Autism: and interesting dietary case history. *Nutrition and Food Science*, **30**, 3, 137–139.

Bögels, S. & Lamers, C. (2001) The causal role of self-awareness in blushing-anxious, socially-anxious and social phobic individuals. *Behaviour Research and Therapy*, **40,** 1367–1384.

Burchardt, T. (2000) *The Dynamics of being Disabled.* Centre for Analysis of Social Exclusion, London School of Economics, London. http://sticerd.lse.ac.uk/case/

Cambridge Learning (2002) Mind-Reading http://www.human-emotions.com/mindreading.

Chou, C.Y., Chan, T.W., & Lin, C.J. (2003) Redefining the learning companion: the past, present, and future of educational agents. *Computers and Education*, **40**, 255–269.

Clark, D. & McManus, F. (2002) Information Processing in Social Phobia. *Biological Psychiatry*, **51,** 92–100.

Di Martino, A & Tuchman, R. (2001) Anti-epileptic drugs: Affective use in autism spectrum disorders, *Pediatric Neurology*, **25,** 3, 199-207.

Fairbrother, N. (2002) The treatment of social phobia – 100 years ago. *Behaviour Research and Therapy*, **40**, 11, 1291-1304.

Fasel, B. & Luettin, J. (2003) Automatic Facial Expression Analysis: a Survey. *Pattern Recognition*, **36**, 1, 259–275.

Fishbein, M. & Ajzen, I. (1980) *Understanding Attitudes and Predicting Social Behaviour*. Prentice Hall, New Jersey.

French, S. (1991) What's so great about independence? *New Beacon*, **75**, 886, 153–156.

Frith, U. (1991) Asperger and his Syndrome. In *Autism and Asperger Syndrome* (ed. U. Frith) pp. 3–24. Cambridge University Press, London.

Horley, K., Williams, L.M., Gonsalvez, C. & Gordon, E. (2001) Social phobics do not see eye to eye: a visual scanpath study of emotional expression processing. *Journal of Anxiety Disorders*, 410, 1–12.

Keller, M. (2001) Role of serotonin and noradrenaline in social dysfunction. *General Hospital Psychiatry*, **21**, 1, 15–19.

Klin, A., Jones, W., Schultz, R., Volkmar, F. & Cohn, D. (2002) Visual fixation patterns during viewing of naturalistic social situations as predictors of social competence in individuals with autism. *Archives of General Psychiatry*, **59**, 9, 809.

Lange, D. & Oshima, M. (1999) Seven Good Reasons for Mobile Agents. *Communications of the ACM*, **42**, 3, 88–91.

Lupton, D. & Seymour, W. (2000) Technology, selfhood and physical disability. *Social Science and Medicine*, **50,** 1851–1862.

Moore, D. (2000) Computer aided learning for people with autism for research and development. *Innovations in Education and Training International*, **37**, 3,.

Oliver, M. (1983) *Social Work with Disabled People*. Macmillan Publishing, Basingstoke.

Parsons, S. & Mitchell, P. (2002) The potential of virtual reality in social skills training for people with autistic spectrum disorders. *Journal of Intellectual Disability Research*, **46**, 5, 430–443.

Petrushin, V. (2000) Emotion Recognition Agents in Real World. *Papers from the 2000 Fall Symposium on Socially Intelligent Agents: Human in the Loop.* http://www.aaai.org/Press/Reports/Symposia/Fall/fs-00-04.html

Roulstone, A. (1993) Access to New Technology in the Employment of Disabled People in Disabling Barriers. In *Disabling Barriers: Enabling Environments* (ed. J. Swain) pp. 241–248. Sage Publications, London.

Schneier, F.R. (2001) Treatment of social phobia with antidepressants. *Journal of Clinical Psychiatry*, **62**, 1, 43–49.

Van Ameringen, M., Mancini, C. & Farvolden, P. (2002) The impact of anxiety disorders on educational achievement. *Journal of Anxiety Disorders*, **433,** 1–11. http://dx.doi.org/10.1016/S0887-6185(02)00228-1

Van Dam-Baggan, R. & Kraaimaat, F. (2000) Group Social Skills Training or Cognitive Group Therapy as the Clinical Treatment of Choice for Generalised Social Phobia. *Journal of Anxiety Disorders*, **14**, 5, 437–451.

Weller, M. (2002) *Delivering Learning on the Net.* Kogan Page, London.