Designing a tailorable environment for children with autistic spectrum disorders

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Abstract

The prevalence rate of individuals with an autistic spectrum disorder (ASD) is estimated to be approximately 91/10,000 in the UK. Children with ASD may vary in the extent and type of symptoms they display, but all have the triad of impairments in social interaction, communication and restricted patterns of behaviour. Given that research suggests that early intervention can maximize the potential of a child with an ASD and each child has a unique profile, there is a clear need to develop systems that are not only of benefit and pleasure, but that are also tailorable to individual characteristics. Also, with the wider inclusion of children with special educational needs in mainstream education, there is an additional requirement that such systems should not just be tailorable to a wide range of children, but affordable and robust enough to form part of the every day school environment. This paper outlines the research undertaken in understanding the characteristics of children with ASD and how such an understanding has led to the development of a low cost, multimedia environment for mainstream schools.

Keywords: Children, user centred design, school design

1. Introduction

Wing and Gould [1] suggested that the expression of autism amongst children was diverse enough to warrant classification as a continuum and when taking into account Asperger Disorder as a more expansive conceptualization of autism, the notion of the autistic spectrum was developed. Individuals with an autistic spectrum disorder (ASD) all display the 'triad of impairments' in:

- social interaction *e.g.* appearing aloof and withdrawing from interaction, inappropriate interaction/appearing 'odd', lack of willingness to share experiences and lack of social or emotional reciprocity
- communication *e.g.* delay in speech onset, inability to engage in conversation, stereotyped, repetitive use of language, use of and understanding of nonverbal communication such as facial expression and body language
- restricted, repetitive and stereotypical patterns of behaviour, interests, and activities *e.g.* preoccupation with one or more stereotypes, restrictive patterns of interest, inflexible adherence to routines and rituals, preoccupation with parts of objects.

The most effective time to achieve break through in these patterns is in early childhood. However, as children may exhibit different patterns of hyper and hypo sensitivity in each of the senses, and, in most cases be unable to communicate their feelings, it is difficult to develop effective intervention programmes.

Approaches to the development of environments to engage children with ASD range from Snoezelen [2] environments to computer applications and robotics [3], through to multimedia environments such as MEDIATE [4]. Evaluation of the effectiveness of any of these is difficult due to the nature of children with ASD.

'Project Spectrum' had three aims

- to take a user centered approach to the development of an environment, based on an understanding of the needs of children with ASD
- to provide a polysensory environment that could be tailored to meet the needs of individual children
- to develop a means of evaluating this and other systems.

This paper will address each of these

2. Understanding the needs of children with ASD

Ideally we would have liked to have worked directly with children in developing requirements for the environment, this was not possible because, firstly, it is very difficult to gather requirements from young children in general; secondly, most of this particular user group would not be able to communicate with us; and thirdly, working closely with a small set of children may not provide the representative sample required. Instead we adopted a 'design for users' approach.

This was based on an understanding of the end user population through personal experience, observation, semi-structured interviews (with parents and, where possible children) and questionnaires. Jackson took the lead in this part of the research, and has first hand experience of the problems of children with ASD, and being a well known commentator in this area had an extensive network to draw on.

Firstly a web-based questionnaire was used to ascertain the profile of children with ASD, their sensory preferences and previous experience of multi-sensory rooms. From the 500 responses we established a profile of the intended user group and the levels of tailorability needed to accommodate most of the children (see Table 1).

These findings were corroborated through observation of eight children from different parts of the spectrum, playing in a traditional multi-sensory environment.. This provided information on the effects of environmental differences on the behaviour of individual children (such as different types of music and lighting effects). Recognizing the need for depth and meaning when interpreting data, 25 semi-structured interviews were conducted; 10 with teenagers with Asperger's Syndrome or High Functioning Autism and 15 with parents of children on various places of the autistic spectrum.

Lastly, in order to build a rich picture of the life of a child with ASD for the designer, and contextualise the system, detailed descriptions of a 'day in the life' of 5 children were created to show how ASD affects each child and where an interactive environment might fit into daily routines.

Rather than simply relying on the data provided from the social research, the designer, Woolner, gathered first hand experiences through associations with special and main stream schools where he worked alongside the developers of other systems and their users.

2.1. Specimen results

We believe that we have gathered one of the most detailed pictures of children with autism that will be of great value and practical assistance to designers, and the subject of forthcoming papers. Summarising these results reduces the complexity of the problems and the richness of the data .

Table 1: Summary of results from the Internet survey

	Lower functioning children	Higher functioning/ Aspergers
Prefer	Red	Blue
	Round shapes	Circular shapes
	Nursery rhymes, meditation music	Rock/pop music
	Smooth, soft and downy textures	Smooth soft and downy textures
	Mirrors	Projected light effects
	Soft play areas	Soft play areas
	Sound, light equipment	Sound, light equipment
Dislike	Sticky, slimy or prickly textures	Sticky, prickly, slimy, rough textures
	Loud noises and specific noises	Loud noises and specific noises
	Sensitivities to smell	Smells, certain lighting
	Interaction and engagement	Interaction with others

Bearing this in mind, Table 1 provides an edited version of results from the Internet survey, showing the extent of tailorability the system will need if it is to accommodate children at each end of the spectrum. This also shows, that children with ASD have sensory issues in terms of olfactory, tactile, vestibular (movement), auditory and visual input. If the final system is to facilitate sensory cohesion then each of these areas has to be addressed and opportunity provided to gradually introduce some dislikes in order to decrease sensitivities.

Observations made in traditional, multi sensory environments showed that although some children derived benefit from these, displaying both enjoyment and relaxation, there were noticeable differential effects caused for example by lighting, on those with Asperger's Syndrome and those with 'classic' autism.

These observations highlighted the complexity of designing for this group. For, example, some parents reported that although their children enjoyed the experience, they became over stimulated, hyperactive and aggressive for the rest of the day. A balance is therefore needed whereby the system encourages interaction with the world, but does not over-stimulate. We cannot simply design a system that children will enjoy, but have to consider the short, medium and long term effects as well. Given that each child has their own profile of preferences which maybe based on their hyper and hypo sensitivities and crossovers between the sensory input, this is a challenge.

Most children became calmer and more relaxed from tactile input such as immersion in the ball pool, being squashed under soft bean bags or spun around in a hammock. We may conclude that although tailorable digital media may be useful, there is also a need for concrete, tangible objects to be used, perhaps at the start of the sessions for relaxation. This might allow the children to be more focused and able to work and interact with the visual and auditory stimuli offered to them.

From the interviews with parents the following themes emerged: the relationship between colour, mood and behaviour; the prevalence of spinning (self or objects) across the spectrum; differences and difficulties in movement and co-ordination; the importance of control and predictability for the children (to provide feelings of security); ethics and identity were also major themes.

However, how these become manifest is dependent on the child. For example, one child may like to spin small wheels, and another spin himself. For one child we may wish to increase certain behaviour, for another reduce it. Such differences point to the need for a tailorable system that can not only be adjusted to each child, but which can allow the child to increase their interactions with it.

2.2. Macro-level requirements

Whilst the requirements for the range of tailorability needed to accommodate children at all places on the spectrum emerged from focused activities with parents, children and carers, the macro level requirements emerged more slowly through discussions and working with schools and other members of the community.

Different types of installations (or environments) were considered - based around a computer, location independent, in part of a room, or a room in a school or leisure centre. This was coupled to the need to make the environment as accessible as possible - limiting its complexity, without compromising its functionality and tailorability.

By positioning our environment in mainstream schools, we believe that we will benefit the maximum number of children, as it is now UK policy to include many children with SEN in mainstream schools. This means that all children will have access to an environment that can be adjusted to their own needs and preferences by members of the teaching staff or their care assistants. This decision obviously had ramifications for the room and furniture design as discussed in the following sections.

3. Providing a tailorable environment

The requirements were presented to the designer as tables, case studies, in discussions and visits to other systems. It was found difficult to provide a rich enough description of the requirements through formal methods or design checklists.

Initially this led to a series of poorly integrated early prototypes, which were technology based, stand-alones. For example, the discovery that a lot of children liked spinning, red, circular shapes, and had poor eye-hand co-ordination led to a module in which a series of virtual cogs could be interlinked and spun in different directions. Although this, and similar ideas enabled Woolner to produce initial

prototypes, this bottom up approach failed to create the immersive environment. This approach prevailed for much of the first year, until the macro level requirements emerged, through a consideration of how the space would be accessed (see above), culminating in a 'day in the life' type poster which became a blue print for the design of the modules and how they would accessed in the school environment.

4. Construction and implementation

Project Spectrum at its most basic is an empty, low sensory room in a school that can provide refuge and host tailorable experiences away from mainstream activity. Into this material (digital and tangible) can be added that will help children to become more engaged with the world.

Such an approach is not novel. However, we believe it embodies the requirements needed. Positioning and building the room in a school means that it will be accessible by all children (not just those who can be driven to it), will be robust, achievable within school budgets, easy to use (by teachers and carers, not dedicated technicians), adaptable to everyday spaces found in schools, provide opportunities to integrate with the school curriculum and to invite other children into the space.

Such an environment has been constructed in a local primary school and is now forming the base room of one child with ASD.

Obviously we would have liked to be able to design and build a room to our own specifications, however, in terms of ecological validity being provided with a typical classroom, and overcoming its limitations showed that it should be possible to do this in any school.

The room provided was 6m square, has three large windows that open onto a playground which is very noisy during break times. It had a high ceiling, lit by strip fluorescent lighting. The floor was covered with an aging nylon carpet, the walls painted beige and covered in posters, pin up boards, black boards and an old interactive whiteboard.

Figure 1: The screen as mirror

Woolner converted this to a low stimulation sensory room (see Figure 1) by stripping and repainting the walls white and replacing the floor with natural marmoleum. Blinds were made from white blackout material to block out light. The strip lighting was replaced with daylight bulbs and an LED lighting system installed to allow for control of the ambient light colour. Furniture was minimal and standard, and organised in such a way as to allow individual and paired working, both in the context of the classroom and when participating in the interactive modules. The room now includes a desk, soft play area and rocking chair.

Although the school has been generous with its space and the help and tolerance we have received, working to within the regulations for school buildings means that we have not been able to erect screens and concern has been expressed about the blinds and closed door in the room. Also, the room itself was initially perceived as sterile, and is acoustically problematic. Significant investment would be required to correct the acoustics in the room to the highest standards.

To accommodate the polysensory environment a custom projection screen was installed along with a data projector, positioned to allow for interaction with digital content. Two cameras, speakers and a computer system were installed to deliver the digital content. Figure 1 shows the screen acting as mirror to allow the user to become used to seeing himself and interacting with others on the screen.

To date, nine modules have been developed based on the requirements. Each of these can be tailored to allow lesser or greater interaction. In all cases the modules have been kept as simple as possible so that there is an obvious and direct correlation between the actions made by the child

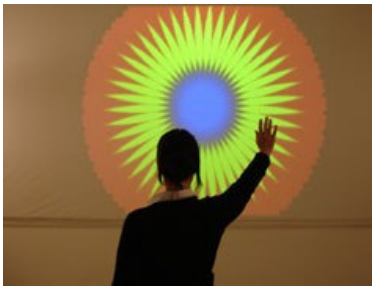

Figure 2: Using movement to control abstract representations

and what appears on the screen. The opening module, as shown in Figure 1, merely gets the child used to the environment, and seeing themselves on the screen. In Figure 1, the carer is also shown as a precursor to introducing later modules that will require levels of social interaction.

Figure 2 shows a later module based around enhancing movement and co-ordination. Earlier versions of the module (based on a kaleidoscope of faces) were too complicated and bewildering. In this example, movement of the arm and body triggers changes to the pattern being displayed.

All modules have been installed in the system and are currently being tested in a six week evaluation programme, at the moment based on a single user.

5. Evaluation

Evaluation of therapeutic environments for this particular user group is difficult for several reasons. Firstly, because the children are not able to tell you what they feel; secondly because each module might effect the user in a different way; thirdly, because any effects of working in the environment may be swamped (in the immediate, short and long term) by extraneous variables. For example, sensory experiences encountered on the journey to school may be overwhelming, medication and other therapies might change, personal issues might lead to temporary withdrawal from all forms of interaction.

Any evaluation process has to take account of these factors. As mentioned in Section 4 we are currently in the early stages of evaluation. This is the second pilot evaluation. The first provided a technical trial - to establish sound and visual quality. This also provided first hand experience of difficulties in evaluation as one of the participants dropped out because of peer pressure, and our main user was 'uncooperative'.

However, we have developed a formative, illuminative evaluation strategy which takes into account base line behavioural measures, contextualisation of the experience and the degree of engagement with the specific module. Where possible the feelings of the user will also be recorded. In summary,

- base line behaviour will be compared before and after the trial using ATEC [5]. This is filled in by parents
- a simple checklist for use by the carer, has been developed by Jackson to measure changes in behaviour before and after each module. This will be transferable to other programmes and environments
- a diary is kept by the carer and where possible, the user. This includes two parts - one to record the interaction with the module and the second to provide more general information which may effect the session
- video analysis to provide quantitative data on levels of engagement with the material.

Once analysed, the results will be fed back to the designers for the iterative development of the modules and the relevant school authorities. We will also reflect on and revise the evaluation strategy adopted.

6. Conclusions

An overview has been provided of the research undertaken by Project Spectrum in developing a tailorable environment to nurture the engagement of children with Autistic Spectrum Disorders.

The long term contributions of the project will be in the provision of a method for gathering the requirements from children and their carers, the requirements themselves which may be used to develop other environments, the evaluation methodology and the experience built up by the team.

The project believes that the overall approach, i.e. the development of the environment, positioned in the school, which provides not only a safe haven for children with ASD, but that can be tailored to meet individual and curricular needs will be crucial to enabling children with ASD to integrate in main school environments.

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