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Can computers create relaxation? Designing ReacTickles© software with children on the autistic spectrum

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People on the autistic spectrum are characterised as having difficulties with social and communicative functioning. They are understood to have unusual sensory experiences, in any modality, which means that their perception of the world is alarmingly different from non-autistic people. These experiences create confusion and anxiety, and for many autistic individuals their lives are dominated by fear.

A body of research exists, however, to suggest that computers present an ideal medium for reducing the confusing, multi-sensory distractions of the real world and that given the right approach, there is a strong possibility that some aspects of computation could prove relaxing and therapeutic.

This paper will document the participatory design and development methods of the ReacTickles© software, which, by encouraging exploration and experimentation from a simple, structured interface, aims to promote relaxation, encourage spontaneous play, and support learning for children on the autistic spectrum.

The paper will reveal how the entire design process from concept development through to the varied and flexible evaluation strategies, has been informed by the distinct needs and characteristics of the target population.

Keywords: Autistic Spectrum Differences (ASDs); Participatory design; Collaboration; Development panels; Sensory software; Open-source; Play

1. Introduction

ReacTickles© use an expressive form of computation with a range of digital technologies to promote relaxation, encourage spontaneous play, and support learning for children on the autistic spectrum.

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The design features aim to recreate the sensations of gravity, temperature, change, space and enclosure, to foster a harmonious and therapeutic approach to interaction. Using the inherent flexibility and controllability of digital media, the research proposes to enable individualised sensory experiences to support the inclusion of the most severely anxious individuals. It is the playful, feel-good nature of the project, and its lack of any potential for error, that defines the experience. There is no Right or Wrong, just intrinsically rewarding exploration.

The motivation for this research grew from trying to find methods for teaching complex computer programmes to design degree students who had a fear of technology and any form of programming that wasn't a one-step, drag-and-drop action. Finding playful activities to ease this anxiety that could be managed by the most novice student provided the incentive to investigate the development of play, particularly the kind of play activities that adults find enjoyable on a purely sensory level, and to introduce these experiences into the teaching of software programmes. In order to re-discover playfulness, without the inhibitions of adulthood, it was decided to study young children in a natural environment for imaginative play. It was whilst observing the play routines of pre-school children in a reception class and talking to teachers that the research found a purpose that would never have been discovered had this remained an academic exercise. Consequently, a relationship began with a group of young autistic children in a Special Educational Needs (SEN) school, which was to provide the foundations for the project.

In a move towards an ethnographic, theoretically informed critical design research practice, formal and exploratory strategies have evolved to enlist collaboration from experts in a variety of fields. The paradox for this interdisciplinary process has been the need to be both imaginative and empirical. Whilst quantitative surveys have been traditionally considered by researchers to be trustworthy sources of information about 'users', the autistic spectrum represents such a wide variety of human beings that a 'typical' user simply does not exist. The underlying needs of individuals are not clearly evident at the outset and are unlikely to be understood from theoretical and statistical perspectives alone. Emotional and practical considerations that reflect the diversity of the spectrum are difficult to generalise and pose extraordinary challenges to the designer. Therefore it has been necessary to develop many discovery-led, qualitative methods in order to consider experiences and explore possibilities, which place the autistic child at the heart of the development, both in real, face-to-face settings and through social media on the Reactive Colours website in an attempt to ensure that participation and collaboration are prioritised at each stage.

The Reactive Colours website (reactivecolours.org) deepens collaboration through the rapid iteration of ReacTickles© software prototypes, a 'suck it and see' process which can quickly adapt to feedback and where those experimenting with the software see the value of their participation as it evolves. It gives individuals a chance to show often-unexpected capacities and make a good impression on other people. This positive effect on other people is a highly significant part of the process.

In addition to using the internet as a collaborative research model, it is proposed ensure that both the site and the software are fully open-source (Coffin 2006, Stadler and Hirsh 2002) to enable users to freely adapt and modify it to suit their unique sensory interests.

2. The theoretical framework

2.1 *Autism and play*

Autism is a pervasive developmental condition that typically appears during the first three years of a child's life. It affects areas of the brain that control language, social interaction and abstract thought (Baron-Cohen 1998, Wing 1975). Although the term 'autism' is used generally within this paper, 'autistic spectrum differences' (ASD) (Lawson 2006) provides a closer definition of the variety of autism conditions.

At the more obviously able end of spectrum the intellectual ability of the individual is often greater than average, due to highly focused interest systems; at the less obviously able end of the spectrum, individuals may lack speech and display severe developmental and processing disabilities. In between lies a variety of autistic behavioural symptoms with degrees of learning disability. Most people with ASD, however, will experience difficulty in three areas, known as the 'triad of impairments', social interaction, social communication and imagination (National Autistic Society).

ASD is not a handicap which prevents physical interaction in social situations; autistic people experience a fragmented or unusual perception of their surroundings which impacts on their ability to process new information in a coherent manner (Frith 1989, Murray 1997, Murray *et al.* 2005). This makes for an alarming world, where anxiety dominates; the order and meaning of events and experiences are frequently misunderstood, causing confusion and stress. From what has been learnt from the testimonies of autistic people, they do not want to be isolated from the world of *normal* people, they are aware of their differences, and often memorise and learn social behaviours; however, they will generally withdraw from situations that are unpredictable and confusing (Lawson 2001).

For young autistic children one of the areas of development most significantly affected by the lack of understanding of the intentions and motivation of others is in play (Jordan, 2003). It is believed that play is the source for human imagination, and therefore of language and reasoning, and that learning occurs through co-experience (Bruner 1972, Dix 2003, Piaget 1962). Play is fundamental to everything we do, and from a very young age is exhibited through children's mimicry of the social activities they see around them. Interaction, mirroring and the emotional interchange between parent and child, condition a child's experiences throughout early years; however, for many children with ASD the poor ability to imitate and respond to the actions of others can result in limited or unusual play activities. In typically developing young children play routines evolve from explorative and manipulative play to imaginative social responses, forming the foundations of social interaction and communication, which directly assist in successfully experiencing and understanding the world (Vygotsky 1978).

Most autistic children do not demonstrate this range of play behaviours, preferring instead the physical approach: playing with an object of interest on a sensory and perceptual rather than conceptual level (Beyer and Gammeltoft 2000). Sensory-motor play of this kind, for example, banging, spinning and oral exploration, such as biting, is often repetitive and persistent and is notably non-goal-orientated (Jordan and Libby 1997, Leslie 1987). However, whilst there is a body of research to suggest that there is a significant deficit in spontaneous symbolic play in children with autism (Sherratt and Peter 2002), some researchers have identified that the ability to engage in meaningful functional play may depend on the child's individual circumstances, particularly their family and learning environment. Given that play skills have a central role in development and that these skills are underdeveloped in individuals with autism, integrating play activities into daily routines could offer significant opportunities for encouraging social interaction, communication and imaginative thinking.

2.2 *Autism and computers*

A computer-based environment presents an ideal medium for reducing the confusing, multi-sensory distractions of the real world, which, in many cases, are anxiety-inducing and may create barriers to social communication. Of equal significance is the role that computers play in enabling shared areas of interest, either in the same physical environment or at a distance. A narrow range of interests, otherwise known as 'monotropism', is one of the diagnostic criterions for autism, so the facility to make areas of interest shareable can assist in both communicative functioning and creative self-expression (Murray *et al.* 2005).

Of the many studies conducted to consider the effectiveness of computers in assisting the learning experience for individuals on the autism spectrum (Jordan and Libby 1997, Murray 1997), it has been the work of Murray and Lesser that has provided a practical definition of why the controllable, predictable characteristics of computers specifically suit the needs of autistic people, particularly in the way that they support non-verbal communication.

The research of Murray and Lesser considers the ubiquity of the computer and how creativity and friendship can be enhanced through the use of computer technology where the demands and distractions of the real world are distanced, if not completely removed. They have observed an increase in communication, sociability, creativity, and playfulness, even among people who do not speak and are regarded as 'low functioning'. This contrasts with the accepted view that autistic people have limited imagination and little desire to communicate with others (Murray and Lesser 1997).

3. The Reactive Colours project

3.1 *Participatory design methods at the beginning—developing a concept*

The research project is called Reactive Colours, which grew from early participation which teachers who identified colour as a useful theme for classroom activities, thus Reactive Colours embodies a participatory process. Participatory design requires direct involvement from the target population, so that all stages of the project are informed from their unique perspective (Druin 1999). In the case of Reactive Colours, although the participatory methods were time-consuming, partly because the problems are so complex but also because of the need to become accepted by the key informants, they ensured that any proposed solutions were designed from the point of view of the autistic child rather than the technology.

3.2 *Feasibility*

The feasibility phase of the project involved interviews with teachers in one special school and one mainstream school with a special needs unit. The purpose of this phase was to identify the context in which play with computers could be integrated into classroom settings and to explore the breadth of software currently recommended for school use.

Computers and computer-assisted technologies are used widely to support a range of cross-curricular activities in all schools with a provision for SEN. The use of Information Communication Technology (ICT) in classroom settings is guided by the notion of the computer as a functional tool that purposefully moves a child beyond their range of abilities by providing a task; computers are seen as having explicitly educational rather than play value and teachers are under pressure to evaluate the learning experience against pre-determined guidelines which are designed to measure skill and do not promote 'feeling good about oneself' as a measurable objective for attainment. National Curriculum Guidelines and Performance Descriptors for ICT are widely used in all schools providing Special Education in the UK, and so it was suggested that Reactive Colours would fit well within these benchmarks for achievement. The researchers are indebted to a number of open-minded teachers who saw the possibilities in the software for gaining ICT skills through a relaxing, stress-free environment in which skills are embedded comfortably and unobtrusively, thus the earliest context in which the software was used simply enabled teachers to assess competence with the computer.

3.3 *Inspiration*

The staff and children at one particular special school with an ASD support unit have participated throughout the design of the software and although other schools have since become involved, it has been the dedication and commitment of this core group that as made the most significant contribution to development of the project; engaging beneficiaries in the research early on so that they informed conceptualisation and design prior to implementation proved invaluable. Routine visits to the school, questionnaires to parents and teachers enabled the designers to become immersed in the culture of the child and led to understanding how computers can be effective in fostering mutual respect and empathy, simply by providing a precise focus, where interests can be shared. This is not simply a method to involve users in the testing of how usable software is, rather it is to find out what motivates them, what makes them feel valued and what unique characteristics they possess that might not otherwise have been discovered. The close relationship that the researchers formed with the school children and their teachers enabled insight into the intense anxiety that children experience in periods of uncertainty and transition, especially in situations of sensory or cognitive overload over which they have no control. Some of the coping mechanisms for managing high levels of anxiety can be alarming, disturbing and disruptive in classroom situations. This anxious state of mind can inhibit learning in most people, but for autistic individuals the challenging behaviours clearly have a negative impact on the whole learning environment.

Observational studies and 'think aloud' techniques were conducted with teachers and support staff; from these sessions, simple storyboards, with no technical references other than anticipated mouse or keyboard activity, were prepared in drawing books, to quickly capture and represent ideas. The aim was to inspire teachers by showing mock-ups to help them envision possibilities without the need to grasp complex technical processes.

3.4 *Visualisation*

These early idea drawings were later visualised on the computer so that the nature of 'reactive' interaction could be explained and explored with children directly. Whilst these reactive screens were crude in their execution, teachers found them easy to integrate into classroom activities. They were initially introduced to a group of six children, aged five years with the developmental ages of approximately two years, using an Apple iBook™.

Concept activities varied from a blank screen of colour that changed as the child moved the mouse, with simple sounds attached to each movement, to more complex keyboard activated screens that visually transformed and played a sound as keys were pressed, either in a random manner or in sequences that created tunes and patterns. Visual tracking was exploited in a number of mouse-orientated activities. The cursor was the point of focus in the form of a shape that had the capacity to visually change in response to user action, in some cases leaving a trail, outwardly evidencing inner engagement. Sounds were used extensively to provide feedback; for example, the closer to the centre of the screen the louder the sound.

These were experiential forms, broken down into simple steps, with no potential for error, as many children on the autism spectrum find failure intensely aversive and some may be completely demotivated by it (Gabriels and Hill 2002, Wing 1975).

Teachers took photographs and video footage of the children playing in order to observe interaction and engagement. Responses were further recorded in interviews and questionnaires, with both direct (yes/no) and indirect (what/how) questions, which focused on experience, rather than the assessment of skill. In particular, the project team looked for evidence of relaxation and increased confidence with the computer. Everyone was invited to contribute with ideas on how the experience could become more playful. It became apparent very early in this trial that the sensory differences of autistic children were to have major influence on any further developments of the software as some children in the group, even though the screens were made up of abstract shapes and colour, were clearly experiencing sensory overload caused by the combination of movement, colour, and sound. An unexpected joy, however, came when the children expressed delight at the vibrancy and purity of the primary and complementary colour schemes, as brightness and contrast proved to be an enjoyable rather than disturbing sensation.

3.5 *Usability and navigation*

Many of the most effective ways to teach children involve them being paced in an environment with the right prompts and materials and letting them play within that carefully selected place (Dix 2003). When the structured setting provides a space for creativity and imagination, children will usually find their own interesting and novel way for interacting, without fear of failure. Designing a digital setting which could provide structure, rules and prompts and yet still encourages exploration and meaningful discovery provided an enormous challenge (Sherratt 1999). Classroom observations of children playing in their free choice of activity and video analysis of the same children using the early trial software in the classroom provided the ideas for an interface from which reactive colour screens could be selected. Fussy detail needed to be avoided and an appropriate level of focus enabled. Autistic children often have obsessive interests and may have a tendency to focus on details rather than the bigger picture; with this in mind great care was taken to reduce features that could be too attention grabbing. Auditory aspects were also carefully considered to avoid sensory overload and the possibility that sounds may be distracting or disturbing. Following much experimentation the interface took the form of a simple clock. The cyclic movement, pattern, regularity and familiarity provided all the elements needed to create a structure. All pictorial elements were filtered and reduced to a circle of numbers and a linear ‘hand’, of which the pointer end followed user interaction. Each number represented a screen, which could be accessed by one click. Evaluation of the interface specifically considered usability; again using video analysis and interviews, the number of prompts required to motivate choice and the regularity of spontaneous choice were monitored.

Children responded positively to this highly structured, controlled interface, and once the sequence of actions leading to choice had been understood, they were able to make selections, in many cases without prompts, and were observed looking for recognition from others.

4. Participatory design in the middle—defining experience

4.1 *The objectives of the software*

The feasibility phase informed a series of objectives on which a successful funding proposal was based, these were:

- To create a reactive, experiential, interface which could introduce children on the autistic spectrum to the operating functions of a computer in a comfortable, playful, explorative, expressive environment.
- To develop flexible methods for evaluation and customisation in order to explore and inform an innovative design and distribution model.

4.2 *Creating a calm environment*

Methods for facilitating relaxation for autistic children using rhythms, colours, movement, interaction, in an environment that is unhurried where children can take turns and process information at their own speed have been well documented (Moor 2002, Sherratt 1999). However, little has been done to apply these in digital interfaces (Seigal 1996), which generally rely on assumptions and relationships that are analogous to, or stand up as metaphors for real world experiences rather than the recreation of sensations.

In the widely referenced text *Playing and Reality*, Winnicott (1982) suggests that to make relaxation possible the object of play must be allowed to communicate a succession of ideas that are not linked to purposeful outcome. He adds that children need repetition, continuity, sound, smell or touch, the experience of which is often linked to a favourite object, to cope with the stress that occurs during times of change.

Therefore the aim for the production phase has been to recreate the sensation of repetition, pattern and similarity, but rather than this being a visual reconstruction of a physical toy, the design focused on the sensory qualities of interaction, which do not make huge cognitive demands, and which encourage tapping, smoothing, circling on the computer, using the keyboard or mouse. Inspiration came from the objects that children most enjoy playing with, for example, spinning tops, Slinkies™, lava lamps, glow balls and kaleidoscopes, all of which offer repetition and reward through touch.

The reactive screens that resulted were designed to simulate phenomena such as elasticity, velocity, gravity and inertia, with the added experience of creating pressure, which can affect proximity, direction and motion.

The research team also experimented with some of the more ephemeral experiences that create sensations, like popping bubbles, flicking paint and twanging elastic. The emphasis is placed on simple reciprocal actions as the neutral interface allows users to focus on the effect of their actions rather than on a complex sequence of steps required to perform a task. On a small screen the demands on fine motor skills are reduced as even the most casual of interaction is rewarded, which can arouse curiosity and promote self-confidence.

4.3 *Considering context*

With the evidence suggesting that a playful experience could enhance learning, through the relaxing interchange of shared interest, teachers began to trial the software was on a Smart™ Interactive Whiteboard, an ideal environment for shared experiences.

In their analysis of the video footage of children playfully involved through touch and movement at the whiteboard, the development panelists agreed that children were clearly being imaginative—imitating and mirroring, moving and exploring, using gesture and action to express their engagement—as many of the barriers to bodily expression, enforced through the necessity to manage control in the confined space of a computer screen, were removed (see figure 1).

The impact of the child's shadow as it projected onto the whiteboard was of particular significance for the research. In most settings interactive whiteboards are lit in a manner that deliberately reduces the intensity the shadow caused by the projection of the image on the screen. In experimental sessions where the lighting allowed the shadow to appear, children were clearly aware of their own presence on the whiteboard screen and purposefully interacted, experimenting with movement and tension to create dynamic visual effects. This expressivity, when enabled in a structured, supportive setting proved meaningful for the children and there was additional evidence of concentration and joint attention as children were able to use their own fingers and bodies to gain control of their experience in an embodied play activity.

Figure 1. Choosing from the Clock Interface at the Interactive Whiteboard.

4.4 *The cycle continues*

Many trial versions have been created during this middle period of development, with the iterative process of inspiration, visualisation and validation continuing to provide ideas for improvement; the rapid 'suck it and see' approach has enabled mistakes to be identified and quickly reconsidered. The clock has been refined, and after a number of versions which became more complex than necessary, is becoming much closer to a working version, and with this success the identity of the project has taken shape and the software has become known as ReacTickles© (see figure 2).

4.5 *Validation—rigorous analysis of experience*

The evaluation of the ReacTickles© software has focused on how children interact in a range of informal and formal contexts: mainstream and special education schools, an out-of-school club, and in the home.

Within these contexts the nature of interaction with the ReacTickles© interface was explored, using questionnaires and video footage, in order to describe and analyse what motivates emotional engagement and the desire, if at all, to share playful experiences with others. The process has been undertaken to provide insight and inspiration rather than as a quantifiable method of surveying and data gathering. Design decisions have been made on the basis of these observational techniques.

As the design becomes more refined, and closer to meeting the needs of users, a more rigorous quantitative method of evaluation is taking place.

Following advice from experts, questionnaires with scalar choice responses, video-tape analysis and interviews have been undertaken with small classes of children in two special schools with a high proportion of ASD children. Other participants in schools and at

Figure 2. Exploring ReacTickles on the Interactive Whiteboard.

home are continuing to use the Reactive Colours© website and email as a mechanism for sharing their experiences of using the software.

The primary goal of the quantitative evaluation has been to assess whether the task-free mode of interaction can:

- provide a meaningful experience whilst interacting with the software directly or whilst watching others—*waiting and attending*;
- reduce environmental distractions and thus engage a child in a relaxing sensory experience—*concentrating*;
- motivate a child to explore the interface independently with limited prompts or assistance—*pointing and choosing*;
- gain control of the body to act purposefully with others—*mirroring and sharing*.

4.6 *Early results*

The evaluation has been specifically conducted with less able children, the benefits of the programme for these children has been highlighted as most significant as very few experiences are available to them that are genuinely motivating.

The initial results of the formal data gathering process, using questionnaires with scalar choices, present an interesting dilemma as a very clear pattern is emerging.

In a structured setting, with children using ReacTickles© on the Smart Interactive Whiteboard, a group of six participants, aged five years, with severely delayed developmental ages (approximately 1–2 years) evidenced increased concentration skills; most of the children were also able to point and choose independently following prompts. The teacher co-coordinating the session noted that, although attending and concentration was dramatically higher as the children were clearly playing happily, waiting and turn-taking was problematic and two children became upset at having to wait their turn.

The same children were introduced to ReacTickles© a week later and some improvement in waiting and turn-taking was noted; the teacher concerned has specifically requested that her study continues over more sustained periods.

In free play sessions, during which children selected ReacTickles© as their choice of activity, the findings were similar. The two children observed showed excellent levels of concentration, with no need for additional prompts, but showed no desire to share.

In a class of children aged nine years, with developmental ages of 12–18 months, the six children observed showed some concentration and attending but needed much more support from their teacher. However, they were more accepting of others in the group when given the opportunity to share the experience at the interactive whiteboard, as the physical environment so clearly provided an appropriate space for joint play.

In another class, six children, aged five, who had previously used ReacTickles© on a Smart™ interactive whiteboard, were able to practice these skills independently and were able to share the experience enjoyably with others.

As the evaluation continues, longitudinal data across is being gathered which will specifically measure levels of challenging behaviours. Challenging behaviours are routinely monitored in all classrooms and residential settings; they are regarded as highly correlated with autistic spectrum differences, and can be extremely costly both in time and money. It has been suggested to consider the immediate effects of challenging behaviours during sessions and the short-term effects in the two hours after using ReacTickles© compared with a baseline derived from records of the prior three months. After regular classroom use of six months or more the team will look at possible longer-term effects on levels of challenging behaviour outside of ReacTickles© sessions against the same baseline.

5. Participatory design for the future—refinement and expansion

5.1 *Personalisation*

The sensory abnormalities which impact on the way in which autistic people perceive events can result in certain colours, sounds, movements, or even textures causing pain and discomfort (Bogdashina 2003). In a classroom setting this can lead to the disruptive challenging behaviours discussed above. Specialist collaborators have encouraged the designers to extend the parametrical environments so that adjustments can be made to reduce the problems caused by sensory dysfunction. New ReacTickles© are being designed to offer user preferences, which can set the volume of sound, intensity of colour and speed of response. Further to this users will be able to experiment with colour directly from the clock interface by choosing a range of complimentary, rainbow or black and white colour schemes. Ultimately, in extending possibilities for creative experimentation, those children who have become confident and familiar with the ReacTickles© routines will have the opportunity to define and customise sensory experiences.

5.2 *Participatory design online*

The Reactive Colours© website has been established to enlist collaboration from a wider community and has attracted regular comments from parents and carers who would otherwise have little opportunity to share their experiences and contribute to progress. The informal and anecdotal comments shared through the web have introduced a level of participation that would be missed if the project had solely relied on formal methods, most significantly in the way in which parents have witnessed positive benefits of the software for children at home. Instant feedback on the web allows people to express themselves instinctively, without the pressure or bias that can occur in formal settings.

The blog section records the project history, providing an open repository for useful information on all areas of development, where comments are easily added and dialogue flows. This openness and transparency is further supported by the release of the ReacTickles© software on the site, for users to freely explore.

The philosophy of release early and often and listen to your customers (Raymond 1998), which is fundamental to the open source movement, has the benefit of reaching the target population directly in their own environments, where spontaneous feedback is valued and encouraged (St. Laurent 2004). For the young children who are extending their experience of using the software at school into the home, the web site presents an opportunity to enrich the learning experience by enabling families to share activities that have been motivating for the child.

5.3 *Expansion*

As new technologies and services evolve and the role of the computer shifts from functional tool to more ubiquitous environments, ReacTickles© represent a scalable, transferable experience of computation that can provide the skill, satisfaction, confidence and reassurance needed to support the seamless transition from one immediate environment to another and in so doing, provide a valuable link between home, the classroom, workplace and the community. ReacTickles© are not intended as a substitute for existing educational approaches, however, by incorporating the software into an overall educational strategy, the software may be well placed offer a positive playful, inclusive, mutual experience for all learners. ICT for the future will need consider the entirety of children's experiences of the technological environment rather than discreet elements of it—yet the challenge remains to ensure that the integration of any informal tools for learning can be pedagogically grounded whilst at the same time playful and rewarding (Plowman *et al.* 2003, Lucklin *et al.* 2003).

With this in mind the Reactive Colours© team are leading a proposal to work with Birmingham University, School of Education, to develop a ReacTickles© DVD Creativity Box, which will directly address areas of the Curriculum.

6. Conclusion

Computers have been shown to have enormous value for people on the autistic spectrum and those in the wider community who support them. Within this paper the researchers have considered many approaches, which use computers to assist in understanding social co-operation.

In the long term, the impact of gaining skills with computers can assist not only in gaining academic, managerial and social skills, but also in boosting confidence and self-esteem. The significance of the Reactive Colours© research has been the departure from the necessity to gain skill, but rather to enable an environment where individuals are free to express their interests, which can be shared with others. Each touch or keystroke immediately creates a visible response so that the current area of focus can be identified and comfortable interaction can occur around a shared interest (Murray and Lawson 2006). For the linguistically less able children, this provides a manageable, failure free, social climate for joint play, a feature often missed in most software applications.

The task of including these children, who may not choose to communicate verbally and for whom change can be extraordinarily uncomfortable, appeared daunting from the outset; however, the strategies documented in this paper ensured that their ability to inform the direction project was prioritised. Furthermore, the participatory nature of the design process was especially significant for the area of research. Being aware of the end-users as a community gave the researchers greater awareness of the possibilities for bodily and social interaction which could be elicited from the children by the ReacTickles© technology. One of the difficulties of this participatory design process has been the necessity to evolve these strategies alongside design and development. The management of the project has demanded new skills from individuals and new methods for defining deliverables and milestones, where the notion of a deliverable is not necessarily a tangible, visible outcome, but closer to creating a condition from which progress can occur. These conditions arose through the availability and commitment of the many parents and teachers who, through their instinctive understanding of the behavioural characteristics of each individual child willingly, on the internet and at school, shared the minutest changes they observed and each incremental change has contributed to the understanding of possibility.

Without this involvement they project may have become a feast of 'reactivity' solely within the domain of the designers; making the design process democratic and visible, has ensured that the software that is not only relaxing and satisfying, but is also desirable, aspirational and delightful.

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Related Links

The National Autistic Society (http://www.nas.org.uk/nas/jsp/polopoly.jsp?d=211)

National Curriculum guidelines for Social Skills for pupils with Learning Difficulties: http://www.nc.uk.net/ld/PSHE_content.html

National Curriculum guidelines for ICT: http://www.nc.uk.net/ld/ICT_perf.html#2

Sure Start—*Birth to Three Matters* framework: http://www.surestart.gov.uk/resources/childcareworkers/birthtothreematters/