Rotoscopy-Handwriting Interface for Children with Dyspraxia

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***Abstract*—We discuss the design and development of computer-animated interface for children with dyspraxia using a specialist animation technique known as Rotoscopy. The technique may provide an engaging environment for children with dyspraxia to improve their handwriting skills, thus increase their motivation and self-esteem towards learning.**

Keywords-Animation technique; prototyping, learning difficulties

I. BACKGROUND

Rotoscopy process involves frame-by-frame projection of moving images to allow the animator to copy every single frame to create a natural-looking animation [1]. A famous film that used rotoscopy is *A Scanner Darkly*, produced in 2006 by Richard Linklater using a specially-developed software system called *Rotoshop*. Originally Rotoscopy technique was invented in 1917 by Max Fleisher for his film, *Out of the Inkwell*. It is named after projection equipment called the *Rotoscope;* where pre-recorded live-action film images were projected onto a frosted glass panel and re-drawn by an animator. In other words, rotoscopy refers to the technique of manually creating a silhouette for an element on a live-action plate to be composited over different background [3]. Figure 1 shows how rotoscopy techniques can create a 2D graphics from a photo whilst Figure 2 is a transformation of a video footage to a short 2D animation. In these examples, graphics images as well as human motion and body shape from a video sequences were traced manually using rotoscopy system to get the image silhouettes, which are then been transformed to 2D graphics and animation. From the output, we can create a new 2D graphics and animation that has similar look and key-frames.

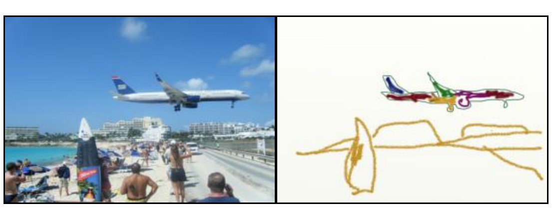

Figure 1. A 2D graphics sketched from a photo

Figure 2. A new 2D animation character created from a video clip

II. RELATED RESEARCH

A. Tracking, 3D Graphics and Animation

Previous research in Rotoscopy has been focused on techniques for 2D graphics and animation, such as *SnakeToonz* [4]. *Keyframe-based Tracking* [2] was proposed as a technique for rotoscopy and animation, which has been improved by *Bi-directional Tracking* [5]. However, both methods produced 2D results and faced similar difficulties. Rotoscopy typically produces non-photorealistic images and animation as it requires more human effort to trace object contours from captured video sequences, whilst tracking is a process in rotoscopy to capture video to be transformed to 2D or 3D graphics and animation. Although a few tracking algorithms have been introduced, previous research in rotoscopy and animation focuses more on video and 2D image rather than producing 3D output. Rotoscopy research for 3D graphics and animation has involved the production of 3D models from video, as well as to improve the image quality. A real-time 3D model acquisition system [6] was developed to assist user to rotate an object by hand and see a continuously-updated model as the object is scanned. However the system has limited functions and required much human efforts. Another research, 3D objects from photographs and video clip [7] has emerged, but it was only for non-animated 3D images. More recently, a new method to capture 3D mesh from 2.5D video [8] has been used, but the result has several limitations such as it cannot distinguish between different objects in the scene, the output cannot be viewed from any direction and there is a flickering problem. A 3D sketching system to create 3D models [9] was developed in 2006 but it has problem to generate correct skeleton and accurate sampling of the silhouette.

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B. *Dyspraxia and Handwriting*

Children with Dyspraxia have difficulty planning and organising smooth coordinated movements [10]. Other terms, such as developmental co-ordination disorder (DCD), clumsy child syndrome, minimal brain dysfunction, and perceptuo-motor dysfunction are also used to describe dyspraxia [11]. According to World Health Organisation's (WHO) report, dyspraxia normally affects 6% of all children and the percentage is estimated to increase as high as 10% [12]. However only a few study related to computer animation technique such as rotoscopy have been undertaken to investigate the potential benefits for people with learning difficulties. This gap provides the main objective and motivation of our research. Application allowing children to be creative and expressive with movement will be beneficial as children with dyspraxia will be engaged with activities to practice their movement and gesture ability.

Research on the efficiency of e-learning and multimedia computer technology for children with learning difficulties strongly recommended such approach as it has emerged positive results to the children [13]. Rotoscopy may also appropriate due to the highly visible nature of the graphical output, which is critical for children with dyspraxia who have difficulties in hand movement as well as handwriting. A study of sign language co-articulation has been undertaken using the rotoscopy technique [14] as it promotes movement to perform signs using hands. Walden's research [15] found that technical advances of rotoscopy have had aesthetic consequences not just for the quality of image but also to the nature of the actor's performance within animation.

In terms of handwriting, Boyle [16] has revealed children with *Moderate Learning Difficulties* (MLD) like dyspraxia can be helped to improve their handwriting using simple intervention programme like speed of handwriting exercise, with support of other general gross motor coordination test. Meanwhile an investigation by Snape and Nicol [17] using a pen-based computer writing interface, has given positive improvement to children, though it hasn't employed rotoscopy for their system.

As a summary, early study of rotoscopy has been established in the area of tracking, video and animation. Previous research in rotoscopy has not focused to handwriting, whilst handwriting recognition system hasn't employed rotoscopy as its main solutions nor supporting children with handwriting difficulties. There has been little research investigating the potential of Rotoscopy as a learning tool. However the success of *ReacTickles®* [18] software, a relaxing and playful experience with technology for children with autism, has given us motivation on system design and development.

III. METHODOLOGY

A. *Why Rotoscopy?*

Rotoscopy may provide a suitable handwriting application as it allows the user to trace hand movement along specific guided lines. Furthermore, rotoscopy enables children to learn through play via tracing and drawing of still images and video footage. The flexibility of rotoscopy is another benefit for children with dyspraxia as it allows many novel and developmentally appropriate inputs. For instance we can use a favourite character as a background image as a practice for hand movement, or a live video of children faces and tracing it using rotoscopy system.

B. *Experience Prototyping*

We are currently developing series of prototypes using Experience Prototyping [19]. This method tries to demonstrate content and identify issues and design opportunity. These normally can be achieved by exploring through direct experience of the systems. The designer need to apply the concept of "exploring by doing", especially to get high fidelity for simulation developed from existing experience (actual products) that cannot be accessed directly due to safety, availability and budget issues or constraint. We have to consider several factors such as contextual, physical, temporal, sensory, social and cognitive issues, the essence of existing user experience and essential factors that our design should preserved. At early stage of developing a user experience, multiple design directions need to be efficiently prototyped and compared. Temporary or ad-hoc use of analogous objects as props can help to decide which kind of experience is most appropriate. The main purpose of this phase may includes facilitating the exploration of possible solutions, directing the design team toward a more informed development of user experience and identifying tangible component who creates the system. The role of experience prototyping in this level is to let our client, design colleague or user to understand subjective value of design idea by directly trying it in their own, or in other words to let user experience the product. It is usually accomplished by persuading the audience or user such as saying that the idea is compelling or the chosen design direction is not right or incorrect.

C. *Usability Testing*

The implementation of prototypes and the testing process will be held at the Dyscovery Centre, University of Wales, Newport, a special research centre for children with dyspraxia and other learning difficulties. The metrics of testing are video coding and observation, involving series of different version of prototypes. We use *Wechsler Intelligence Scales for Children®* (WISC) [21] as the evaluation standard.

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WISC is a special intelligence test designed for children age 6 to 16 to generate their IQ score as well as to diagnose children's learning disability. The results will be measured on children's performance, and how the application helps users improve their gross-motor skills, as well as their interest and motivation towards learning. For video coding, we will record children activity with the system during series of workshop held at the Dyscovery Centre. This will includes a record of children handwriting process to allow a replay and analysis of their result.

D. Medium of interaction

The interactive whiteboard has been used in classroom to test early prototypes as well pre-handwriting activities. It has been chosen as it is easy to use as it has touch screen mode that allows children to make free hand movements on the screen [22]. The concept is quite similar to pen and graphics tablet but in more spacious movement area. Previous research using pen-based computer writing interface [23] has considered it was as efficient as, and produced comparable writing to the pencil and paper. Figure 3 shows example of different size of interactive whiteboards including children playing with the device.

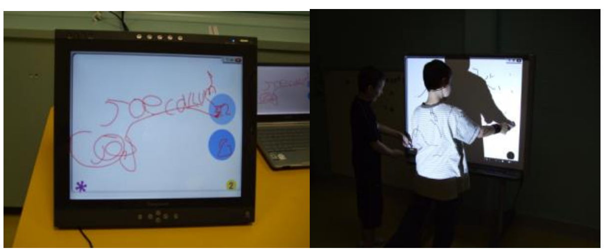

Figure 3. Different size of interactive whiteboard

IV. ROTOSCOPY-HANDWRITING INTERFACE

At the moment we are investigating rotoscopy technique to identify whether motivation and engagement can be increased by using a performance-led embodied approach, which would allow children to practice handwriting using gross motor skills, for example bodily movement and gesture; as our research aims to give children with dyspraxia a playful and physical experience in developing their handwriting skills. The development and implementation of the systems have been focused on the benefits of using interactive whiteboards [24], as large-scale environments that support gross-motor skills and performance. Rotoscopy technique has been used to trace a projected image on an interactive whiteboard screen. The prototype system developed using 2D and 3D animation software has been utilised and adapted to respond to user activity in such a way that the mirrored or abstracted image enables the child to visualise the activity and to recognize the projected actions own.

This mirroring capacity of the system is vital for the development of social communication and learning [25]. For this reason rotoscopy is chosen to be used as a technique to assist children with dyspraxia, who are known to experience problems with low self-esteem as a result of co-ordination difficulties [26].

A. System Pipeline

Figure 4 illustrates the system pipeline which contains the research problem, objective, methods and solution. In other words our research tries to prove the effectiveness of rotoscopy as an appropriate solution to assist coordination difficulties and to improve handwriting skills among children with dyspraxia. It is clear that the study occupies user-centred design and experience prototyping as rotoscopy-handwriting prototypes has been used as a tool to improve handwriting skills among children with dyspraxia as well as to support their gross-motor skills.

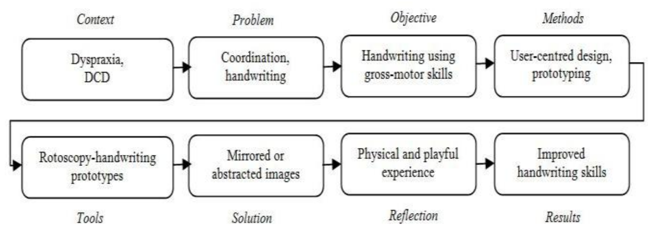

Figure 5. The rotoscopy handwriting system pipeline

B. Prototype system

The prototype system is designed to assist children with dyspraxia to practice their handwriting skills through movement and performance, rendered visible to them via the projection of actions onto a large surface. Evaluation methods will measure the extent to which the animation of movement in a child-friendly graphic form can engage children's motivation and lead to improved handwriting skills [23] The prototype has been designed based-on Ripley's Methods for teaching of handwriting to children with dyspraxia [11]. Ripley's method consists of different stages of skills, starting from drawing basic shapes and symbols to get familiar with lines and curves, followed by writing basic numbers, simple to more complex letters, and ending with writing children's own name.

We divided this approach into 5 different level of prototype: Prototype 1: Group 1 to Group 4 Symbols, Prototype 2: Numbers, Prototype 3: Circle Letters, Prototype 4: Wiggly Letters and Prototype 5: Child's Name. Each stage has different level of difficulties that need to be completed before the student can move to next higher level. Figure 3 and Figure 4 are examples of early version of the prototype interfaces that contains the first two groups of basic shapes.

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These shapes are a basic hand movement and gesture practice for children with dyspraxia before they learn more complex letters. Children's interaction with the system occurs with the use of interactive whiteboard to test Rotoscopy-Handwriting prototype. For instance, in Prototype 1, Group 1 to Group 4 symbols, children or user need to master basic lines and shapes in order to train their hand movement. Group 1 consist of three most fundamental shapes, a horizontal line for hand movement from left to right (and vice versa), a vertical line for hand movement from top to bottom and a circle for round or curve hand movement.

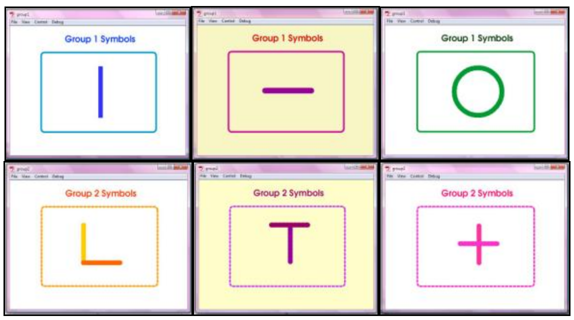

Figure 4. Group 1 and Group 2 Symbols

Figure 5 depicts examples of the first three interfaces of Group 1 symbols. The system will allow children to draw horizontal and vertical lines as well as circles on interactive whiteboard using early the version of rotoscopy-handwriting prototype. Every interface has several number of lines or circle to give more chances to children to practice. Different types of line-pattern as well as colours have been used to engage children to learn through play.

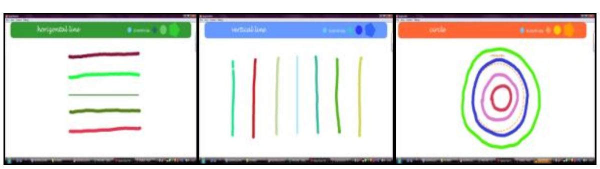

Figure 5. Prototype 2: Group 1 symbols

Meanwhile examples of learning to write a single letter are shown in sequences from start to end (Figure 6 to 8). In Figure 6, the first interface is steps with arrows to show how to write the letter and the second is demo animation of the steps. In Figure 7, the interface shows the rotoscopy process, where users are allowed to trace the letter, followed by two interfaces for exercise as shown in Figure 8. For exercise, the first interface allows user to train to write the letter with reference or guide (a watermarked image of the letter), but the second is an exercise without references, assuming the user already know how to write the letter.

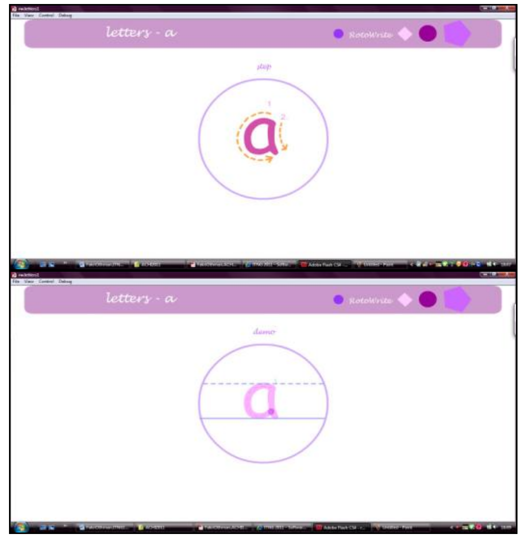

Figure 6. Steps and demo animation

Figure 7. Rotoscopy interface

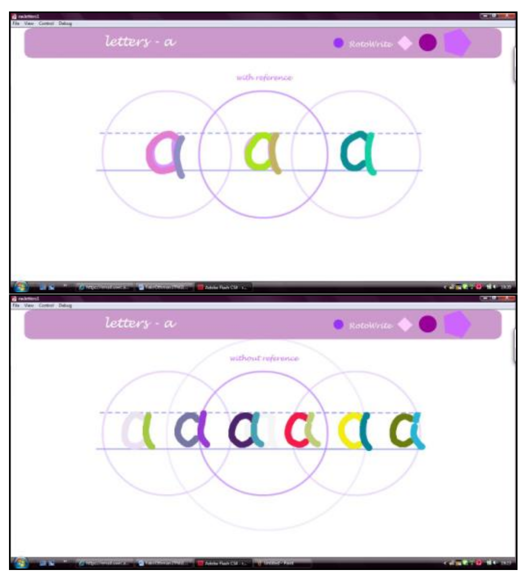

Figure 8. Sample of rotoscopy exercise

C. Pre-writing interface

We have included a pre-writing interface to see how children with dyspraxia and typical-developed children response to system's design and usability. Figure 9 shows drawing results obtained from a group of typical developed children age 6 to 9 using the screen and playing with rotoscopy function. In this activity, children were encouraged to produce free drawing based on basic shapes from Ripley's symbols.

Figure 9. Sample result of rotoscopy pre-writing interface

We have also tested the children to draw more complex images, as shown in Figure 10, as they traced real photo to get 2D graphics and images. Their favourite cartoon character has been used as attraction to engage them to trace and draw pictures. It is emerged that such an activity was really fun and interesting for them. From this experiment or testing we try to adapt system design for children with dyspraxia which should be simple, easier and less complicated. The next version of our prototype will use a pen tablet and a monitor. Children will be able to use their fingers as well as the pen to draw lines and shapes on the screen. The size of the shape should be drawn according to the screen's medium of display; for example when using interactive whiteboard; a bigger shape size is required whilst for monitor-based display, smaller size is preferred.

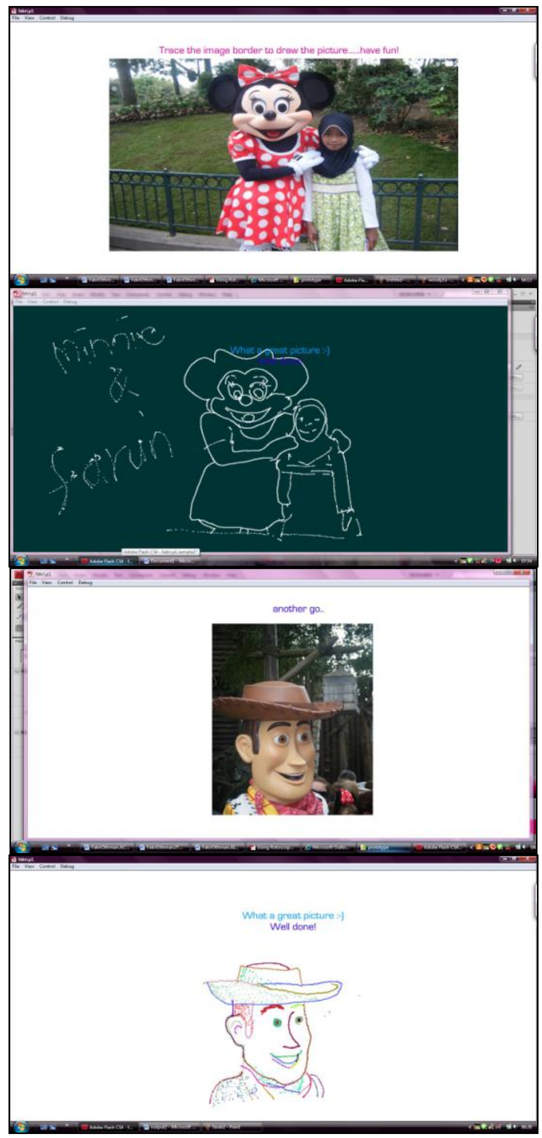

Figure 10. Sample rotoscopy result of cartoon character

V. Conclusion And Future Work

The goal of this investigation is to discover the potential of rotoscopy to assist the teaching of handwriting skills for children with dyspraxia. With evidence gathered from our prototype systems, the proposed methods may place these developments in an original context. Rotoscopy may prove appropriate for children with dyspraxia as it enables them to practice their skills using naturalistic hand movement. In this case, the input and output device play important role as a medium of communication between children and the methods; as this tangible technologies have a close correspondence in behavioural meaning between input and output. Our next milestones will be to undertake contextual analysis [27] of the prototype systems which will include end user feedback and practitioner reflection.

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References

[1] V. Garcia, E., Debreuve, and M. Barlaud, "Contour Tracking Algorithm For Rotoscopy," Proc. ICASSP 2006: IEEE International Conference On Acoustic Speech.

[2] A. Agarwala, A. Hertzmann, D. Salesin, and S. Seitz, " Keyframe-Based Tracking for Rotoscoping and Animation," Proc. SIGGRAPH, Aug. 2004, pp. 584—591, doi: http://doi.acm.org/10.1145/1186562.1015764.

[3] J. Bouldin, "The Body, Animation and the Real: Race, Reality and the Rotoscope in Betty Boop," Proc. Affective encounters: rethinking embodiment in feminist media studies. Eds. A. Koivunen and S. Paasonen. Turku, FI: Media Studies, 2001, pp. 48-54.

[4] A. Agarwala, "SnakeToonz: a semi-automatic approach to creating cel animation from video," Proc. 2nd ACM International Symposium on Non-photorealistic Animation and Rendering, 2001, pp. 139-ff.

[5] J. Sun, et al, "Bi-directional tracking using trajectory segment analysis," Proc. SIGGRAPH 2005.

[6] K. Nickel, et al, "3D-tracking of head and hands for pointing gesture recognition in a human-robot interaction scenario,". Proc. Sixth IEEE International Conference on Automatic Face and Gesture Recognition, 2004, pp. 565-570.

[7] J Ponce, et al, "3D photography from photographs and video clips," Proc. International Symposium on Core Research, 2003.

[8] N. Snavely, et al, "Stylizing 2.5-D Video," Proc. NPAR 2006, pp. 63-69.

[9] F. Levet, et al, "3D Sketching with Profile Curves," Proc. International Symposium on Smart Graphics, 2006.

[10] M. Boon, Helping Children with Dyspraxia., Jessica Kingsley Publishers, 2001.

[11] K. Ripley, B. Daines, and J. Barrett, Dyspraxia: A Guide for Teachers and Parents., David Fulton Publishers, 1997.

[12] M.M. Portwood, Understanding developmental dyspraxia: a textbook for students and professionals., David Fulton Publishers, 2000.

[13] A. Savidis, and C. Stephanidis, "Developing inclusive e-learning and e-entertainment to effectively accommodate learning difficulties," SIGACCESS Access. Comput. , 83, Sep. 2005, 42-54.

[14] J. Segouat, "A study of sign language coarticulation," SIGACCESS Access. Comput. , 93, Jan. 2009, 31-38, doi:http://doi.acm.org/10.1145/1531930.1531935.

[15] K. L. Walden, "Double Take: Rotoscoping and the processing of performance," Refractory: a journal of entertainment media, Dec. 2008.

[16] C.M. Boyle, "An Analysis Of The Efficacy Of A Motor Skills Training Programme For Young People With Moderate Learning Difficulties," International Journal Of Special Education 2007, Vol 22, No. 1, pp. 11-24.

[17] L. Snape, and T. Nicol, T., "Evaluating the effectiveness of a computer based letter formation system for children," Proc. The 2003 Conference on Interaction Design and Children, 2003.

[18] W. Keay-Bright, "Can Computers Create Relaxation? Designing ReacTickles© Software with Children on the Autistic Spectrum," CoDesign, 3, (2), 2007, pp. 97—110.

[19] M. Buchenau, and J. F. Suri, "Experience prototyping," Proc. The 3rd Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques; August 17 - 19, Aug. 2000, doi: http://doi.acm.org/10.1145/347642.347802.

[20] M. Buchenau, and J. F. Suri, "Experience prototyping," Proc. The 3rd Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques; August 17 - 19, Aug. 2000, doi: http://doi.acm.org/10.1145/347642.347802.

[21] E. Kaplan, D. Fein, and J. Kramer, "Wechsler Intelligence Scale for Children® - Fourth Edition Integrated," 2004, Available at: http://www.pearsonassessments.com/HAIWEB/Cultures/en-us/Productdetail.htm?Pid=015-8982-800

[22] W. Keay-Bright, "Designing Playful Sensory Experiences with Interactive Whiteboard Technology: The Implication for Children on the Autistic Spectrum," EAD 07, 2007.

[23] J.C. Read, S. MacFarlane, and M. Horton, "The Usability of Handwriting Recognition for Writing in the Primary Classroom," People and Computer XVIII - Design for Life, Springer, London, 2004, doi:10.1007/b138141.

[24] M. Horton, and J. C. Read, "Interactive Whiteboards in the Living Room? – Asking Children about their Technologies," The 22nd BCS British-HCI 2008, Liverpool, UK.

[25] K. Facer, and B. Williamson. "Designing Educational Technologies with Users", Futurelab, 2004, Available at http://www.futurelab.org.uk/resources/documents/handbooks/designing_with_users.pdf

[26] S.E. Henderson, and L. Henderson, "Toward An Understanding of Developmental Coordination Disorder: Terminological and Diagnostic Issues," Neural Plasticity 2003, Vol.10, No. 1-2.

[27] M. Stringer, E. Harris, and G. Fitzpatrick, "Exploring the space of near-future design with children," Proc. The 4th Nordic conference on Human-computer interaction: changing roles, Oct 2006, pp. 351-360, doi:10.1145/1182475.1182512.