Evaluation, Training and Measurement System for Autistic Children

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Abstract

Special training is vitally important to detect and correct autism in children 2-4 years old. In order to achieve this goal, critical training needs to be performed in a speedy and efficient manner.

We are developing an evaluation, training and measurement system for 2-6 years old autistic children using Squeak and EToys.

1. Introduction

1.1 General Information about Autistic Children

Childhood autism is classified in DSM-IV (American Psychiatric Association 1994)[1] as a pervasive developmental disorder. Childhood autism is characterized as qualitative impairment in reciprocal social interaction, qualitative impairment in verbal and non-verbal communication and a restricted repertoire of activities and interests, with onset during infancy or childhood.

The condition may first become apparent in the first few months of life and, in these "no onset" cases there is assumption that it has been present from birth. In other cases there is a period of normal development usually lasting no longer then 3 years, followed by the gradual appearance, usually over a few weeks or months, of the classical symptoms.

According to various empirical studies autistic children functioned better under structured conditions then they did under unstructured conditions, and that individual variations in response to structure correlated with development levels. Children of lower levels of developmental function benefited more from structure than did children at higher levels.

2. Behavioral features

Impaired speech and language development : Most autistic children are non-verbal[2]. These children eventually learn some appropriate speech but only after intensive therapy and education.

Resistance to change: Autistic children's play is very limited and rigid[2]. The child often develops a stereotyped pattern to his life and becomes very distressed if there is any deviation from it. The table must be laid just so, the classroom and the material must be the same, a walk to the school must follow a particular route.

Attachment to particular objects: Autistic children sometimes become attached to unusual non-cuddly objects, bits of wire, tin, cans etc.

Acute emotional reactions: There are frequent outburst of excitement, anxiety, misery or anger and this may be triggered by alterations in the environment that would not cause any noticeable impact on the emotional life of an ordinary child.

Abnormalities in response to the physical environment: Typically autistic children appear to have a sensory deficit and are generally unresponsive to their environment. This apparent sensory deficit generally causes the parents of autistic children to suspect that their child is either deaf or blind. The children act, at times, as if they do not hear noises, or do not appear to see even when an object is display at right in front of their eyes. However, their vision and audition are intact, and those same children do not respond to loud noises may orient to the crinkling of a candy wrapper or the presence of a cookie. Also, some autistic children overreact to certain environmental stimuli; for example they may cover their ears when a rattle is shaken. This abnormal responsiveness is associated with the tactile sensory modality as well. A child may be oversensitive to a tickle and under-sensitive to pain. [3].

3. The Need for Special Training

Autistic children in general demonstrate difficulties in the learning environment. The children are very difficult to teach, and new behaviors are acquired slowly, if at all. Although many factors contribute to the child's learning problems, such as interfering behaviors and lack of motivation, autistic children typically fail to respond to all cues presented in the

learning situation and tend to respond to only one cue or component in the relevant stimulus environment [4].

Special training is vitally important to detect and correct autism in children when they are between 2 to 4 years old[2]. This training that is done when children are between 2 to 7 years old needs to be very results oriented, interesting and flexible and allow precise measurements performance of children [4]

4. The Need for a Special System

Autistic children can concentrate a lot harder than normal children and can have physical control problems from time to time. This requires an environment that should be able to be controlled much better than an ordinary classroom. An activity such as a teacher opening up a deck of cards or packing some toys, working equipment, recording devices, a teacher turning on or off a device, non-working equipment can all cause the child to lose all attention.

We can state the difficulties that are encountered during the current manual approach:

• In the current approach teachers use a physical object or a toy to grab and maintain attention of the child by moving and playing games and doing the observation at the same time. This proves very tiring for the teacher and difficult for the child. Also makes the observation and evaluation more error prone.

• Grouping of pictures is currently done by a deck of cards. In this exercise preparation and repacking of the cards, the limited number of cards and pictures and recording of the results while dealing with cards add further difficulty to an already very difficult task.

• There is an exercise done with a turning wheel with pictures. There are no current wheel systems that are attractive and able to accurately stop and that can grab the interest of the child by making noise while turning. Also the existing systems do not offer an easy way of changing pictures on the wheel. Furthermore after stopping of the wheel observing what the child pointed to and recording the result manually is cumbersome and error prone.

• In exercises that associate sounds with pictures the training has similar problems to the other exercises such as difficulty of preparation, limited number of pictures and difficulty of manually recording results.

• In exercises that solely depend on sounds the difficulty of teachers producing the same sound, the lack of any visual feedback on matching the sound, the ability to be able to adjust the sound to the sensitivity level of the child and again recording results prove difficult.

• When following lines and curves some children aren't able to hold a pen in their hands. The ability to use their fingers and the ability to accurately record the response is a significant advantage.

The idea of developing a software program to assist teachers to was envisaged by *Nejla Arslankurt* and *Hacı Şahin* of *Ilgi Private Education Center for Autistic Children*. The authors helped the center to turn these ideas into a detailed design and then a prototype of the required system that is slowly evolving to be the actual system that will be used in the center for measurement and training of children with autism.

5. Previous work

Most existing methods used in evaluation and training of autistic children rely very much on the teacher and physical tools and toys.

One of the most novel approaches of using technology to assist training was initiated by a family with an autistic child in form of video communications. Based on taking videos of activities and using a reward system to repeat these videos to the child they achieved significant success. This work is documented by *Liisa Neumann* in a book[7] and now referred to in various studies.

Another approach to help autistic children learn faster and better is to use a combination of general purpose software developed for other purposes such as text reader programs for sight impaired people and more general tools developed for children. Some of the most notable work using such programs comes from India in the works of *Dr. Arun Mehta* who with *Vickhram Crishna* initiated the development of the open source *Hawking Communicator*[6]. The film that document their workshop in Dehradun in 2006: *A for Autism... M for Mouse* [7] is one of the most significant pieces of documentation in this area. *Dr. Mehta* and *Mr. Crishna* continue their research with a combination of tools they developed for the *Hawking Communicator* and some other tools used by children. Some of the important tools they use include *Natak 3D drama editor* which is a 3D program where children can create their own stories ad dramas[12], *Jaws® reader* that is mostly used by people with eyesight related problems[13], and *Stratch*, an MIT developed visual scripting system[14]. One of the significant pieces of observation they made during the Dehradun workshop and later studies was that most autistic children who have difficulty interacting with other people were more comfortable with computers.

However they also found that some children were hypersensitive and some could not deal with the glare in some computer screens. They addressed this issue with tools such as Jaws reader which was able to read what is on screen to children.

5.1. Existing Software Developed for Autistic Children

There is some software that is specifically designed for people with special learning needs, including autistic children. They are too numerous to summarize accurately in the scope of this paper but a web search yields several titles. A majority of these are devoted to language acquisition and development, some in non-verbal ways, others more sophisticated, covering writing and grammar skills. More than 50 titles are in the market for language related software, mostly for the English language although there are other languages supported. Among them are several titles developed by *Laureate learning systems* which offers titles such as *First Words I, II, First Verbs, Exploring Nouns and Exploring Verbs* and *Language Activities of Daily Living*. [15]. *Jabuguín,* a piece of software that came out of experience of a family with their autistic child was originally in Spanish and now available in English also[16].

Another significant group of software targets social skills. More than 10 titles are available for general and special occasions such as birthdays and school. School subjects also form an important category. Math, geography, history and other subjects are also covered with a variety of software.

One of the most impressive and important pieces of software that is worthy of mentioning here is the *MindReader* system developed in the *Autism Research Centre* at the University of Cambridge in the UK by *Simon Baron-Cohen* and colleagues[11]. The software categorizes all human emotions and helps the user learn and differentiate between these emotions.

Most of the existing software require the minimum age of the child to be over 5 and in many cases 8 to 10 years old. None of the existing software seems to be designed to assist teachers to evaluate and train a child with help of an instructor, and measure improvements throughout the training. Furthermore very few of the existing titles are in Turkish, where the software will have to support Turkish and/or lend themselves to be translated into another language.

6. Intended Use of the System

The system is being developed in order to close the gap between the needs of the teachers and material to use in the classes, to train the educators and improve the quality of training. The system will be used by specialized teachers and supervisors at *Ilgi private Education Centre* in Ankara Turkey within a special program under the supervision of the experts of *Hacettepe University* and will be evaluated by these experts:

- Prof. Dr. Ferhunde Öktem PHD Clinical Psychologist
- Prof. Dr. Fatih Ünal MD Child Psychiatrist
- Seniz Özusta Clinical Psychologist

The system will be tested within a study to be able to objectively measure the benefits of the introduced system by the experts.

The initial group of students will be 40 children selected from the patients of the Medical School of the Hacettepe University among 2-4 year old patients with autism. A pre-requisite will be that the child would not have participated in any special training before.

Each student will be educated in his/her own group, within a four months individual education program which was prepared according to “applied behavioral analysis” methods and techniques, and their developments will be recorded (enlisted).

6.1 Procedure

In this project materials (devices) specially designed according to the learning characteristics and conformations of autistic children are developed and training rooms equipped with these materials are constructed. Each of these education spaces are called an “education unit”. The aim is to make autistic children of 2-4 ages acquire basic skills as a precondition for their progress, rapidly and permanently.

This method will be used in a broad research with the collaboration of the Hacettepe University and the special education center Ilgi Private Education Center.

6.2. Selection of the Programming System

To be able to rapidly prototype the system authors tapped into the power of the Squeak Smalltalk system which proved to be very powerful in developing complex ideas into working systems as seen in the systems such as Plopp, Stratch that was used in India by Dr. Mehta, and even Open Croquet[17]. Moreover a lot of the aspects of the required system lent

themselves very nicely to the EToy system of Squeak which enabled the main developer of the system who didn't have any previous Squeak experience or a strong programming background to start developing from day one of working. Where EToys weren't sufficient or practical, then the underlying Squeak system was utilized to resolve any problems

The system is designed to address many issues mentioned in the section xxx and to maximize the intensity and the precision of the training and the accuracy of the measurement. The hardware and the software requirements are summarized below:

7. Hardware

The hardware required for the system is standardized to a dual core fast system with 2GB of memory and plenty of disk space to be able to store video archive, 1 monitor with touch screen, 1 regular monitor, 1 keyboard, 1 mouse, 1 camera, 1 microphone and one set of stereo speakers. A mechanical wheel capable of informing what position it stops is also a part of the system.

The hardware is specifically located into the training area (Fig 1). The touch screen is placed right in front of the child with the speakers, microphone and the camera also placed in front and sides in a non-obvious manner to not to crowd the area and disctract the child. The other monitor, mouse and the keyboard are located to the side of the teacher who sits right behind the student. The wheel is placed to the right of the student. The RFID position sensing system is supplied courtesy of Blue Plane Pty Ltd as an easy and ready made solution to detect position of the wheel and a possible interface for any future requirements such as detection of location of physical objects.

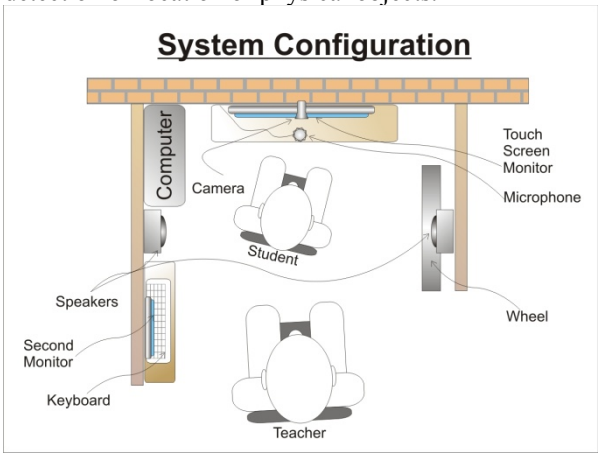

Figure 1: System Configuration

8. Software

The system designed has 4 main parts that correspond to the existing non computerized training. Exercises at each part have either automatic or teacher determined scores that get recorded. The system also includes a reporting module.

The following sections detail these parts and other sections of the software:

8.1. Training Part 1:

The teacher chooses an animation from the list of attractive animations which has an object moving in different speeds and following various paths(Fig 2).

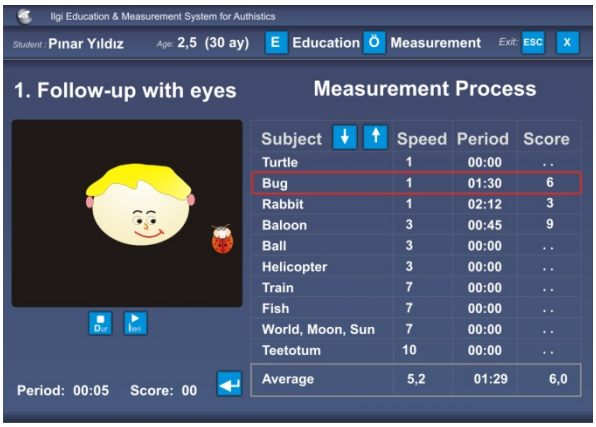

Figure 2: Animations screen

The purpose of this exercise is to observe and evaluate how a student follows a moving object with his or her eyes.

Animations generally have a single object (Fig 3) or if there is more then one object they move very close to each other. At this moment the teacher can see the face of the student in a window of his or her screen which has a dot on it that represents the object(s) of animation. By following the dot the teacher can easily decide if the eye follows the action of the object by seeing the eyes of the student and the object indicator of the animation at the same time. The most likely scenario is that teachers will start to show the animations from slower to faster ones.

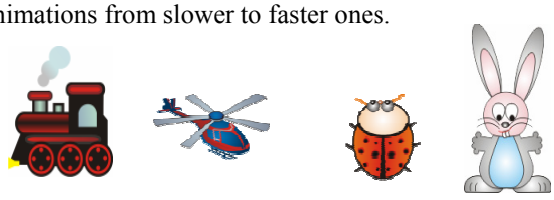

Figure 3: Some of the animations used in eye follow exercise

The objects used in the animations include a turtle, a ladybug, a rabbit, a balloon, a ball, a helicopter, a train, a fish, the world & moon, and similar objects.

In this part, the teacher evaluates the accuracy and speed of eye movements of the child and gives the score manually.

8.2. Training Part 2:

This Part has two sections. The first section is choosing one of the pictures of a physical turning wheel which is visible when the wheel stops, and the other section is grouping various objects on the screen by using the touch screen monitor.

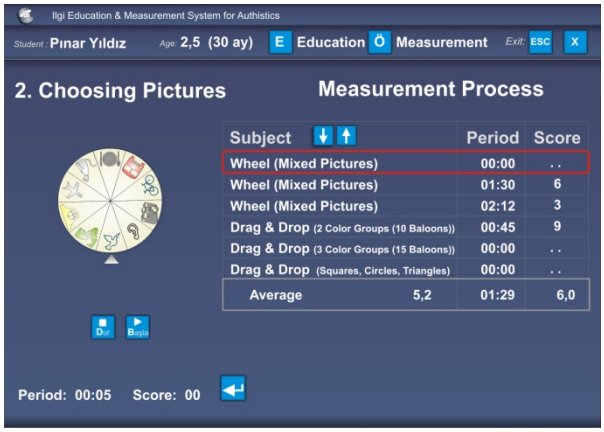

Figure 4: Wheel screen

The student's table has a wheel which has 9 pictures on it. The teacher turns the wheel which is near the student (Many autistics like to watch turning objects). It stops after turning about 20 seconds. Indicator on the wheel shows a picture when the rotation stops and the teacher wants the student to show the same picture from the table on the screen. The student touches the picture he wants. In this section, computer detects the picture the indicator shows by the help of RFID tags on the wheel (Fig 4). The wheel has various sets of pictures which the teacher can easily fix them to the wheel by the help of magnets.

In the same screen teacher may also request to choose a picture from a student by calling the name of the picture.
In the second section, there are some objects to group with drag and drop method by using touch screen (student) monitor. The objects can be grouped to the colors, shapes, etc.

In this part, the computer evaluates the results and determines the score.

8.3. Training Part 3:

In the first section of the part 3, the system has a voice archive like cat's meow, snoring man, alarm clock etc each with a corresponding picture. The teacher plays one of the sounds for the student to touch the relevant picture on the screen (Fig 5).

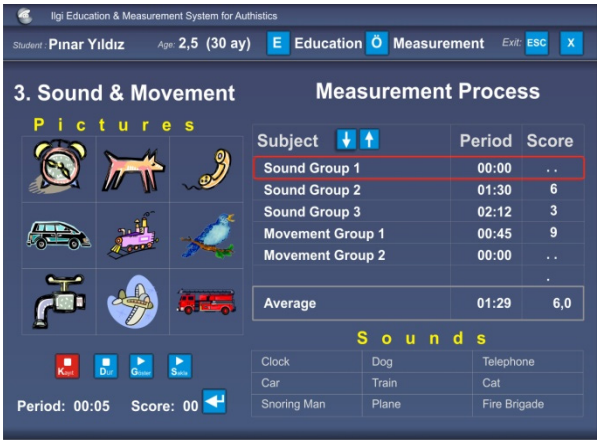

Figure 5: Sound recognition

In the first section of part 3, the computer evaluates the results and determines the score.

In the second section, the teacher plays a voice, and requests a similar voice from the student. The teacher records the voice of student, and plays it back to the student to listen and observe the difference.

In the last section the system has some human animations like touching to nose by forefinger, clapping hands, etc. The teacher plays one of these animations, and requests the similar movement from the student. The teacher may record the movement of the student and displays it and the animation in the same time to show the difference to the student.
In this part, the teacher evaluates and determines the score.

8.4. Training Part 4:

In the last part of the training the system offers various lines, curves and shapes that are geometric or like letters I, E,O, etc. Teacher chooses one of the shapes and shows it on the student's touch screen. The teacher requests from the student to trace over the

existing shapes by using his finger. In this operation student draws shapes with a different color. (Fig 6)

In this part, the computer evaluates the results and determines the score.

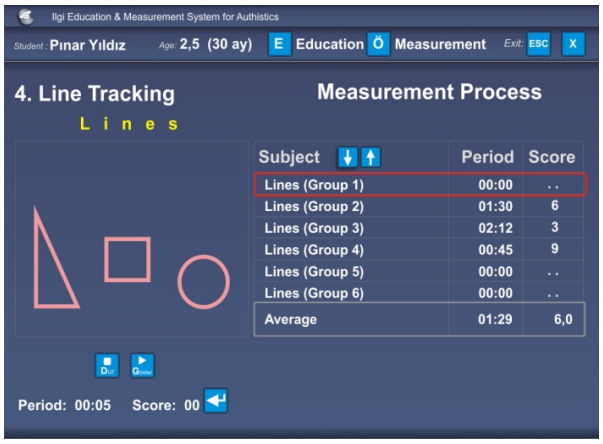

Figure 6: Line tracking

8.5. Reports

All work needs to be archived in order to be summarized into reports that are to be given to the supervisors from the school and the Hacettepe university including table and graph formats. Also information needs to be given to parents who want to follow progress of their children. Reports are generated in comma separated and HTML formats.

9. Current Progress

System has been in development for about three months yet but already more than a half of it is complete. This is remarkable because as mentioned before the leading developer had no previous Squeak experience or a strong software background, and the support he receives only minimal support. First two parts of the system are going to be ready to go to beta testing in January. It is eagerly awaited in the school for initial tests.

10. Conclusions and Further Work

Our first task is to finish the system and put it into use in the centre. We will closely work with the Ilgi Centre and the evaluation and supervision team at Hacettepe University gather feedback and incorporate this feedback into the system. One of the reasons Squeak and EToys were chosen to develop the system was to have the flexibility to be able to update and change the system with ease and minimal interruption, When the system is fully developed we will use Squeak's internationalization support to translate the system to various other languages.

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