AN INTERACTIVE ATTENTION BOARD: IMPROVING THE ATTENTION OF INDIVIDUALS WITH AUTISM AND MENTAL RETARDATION

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ABSTRACT
This paper presents a tool named "Interactive Attention Board" (IAB) and an associated software named "Interactive Attention Boards Software" (IABS) for individuals with Mental Retardation and Autism. The proposed system is based on several theories such as perception and learning theories, and it is intended to improve hand-eye coordination and attention duration of disabled individuals. Furthermore, the IAB system offers an interactive environment both for disabled individuals and educators, and enables a rapid improvement of disabled individuals' responses to various stimulants, and increases attention duration on a certain object. IAB aims to decrease disabled individuals' reaction time to stimulants, and to increase total concentration and attention period on a single object. Thus, these improvements in the attention help the educator to teach individuals about various cognitive concepts such as long, short, small, big, and colors, as well as educational concepts such as animals, vehicles and professions.
Keywords: interactive learning environments; teaching/learning strategies; human-computer interface; computer aided learning

1. INTRODUCTION

Interactive Attention Board (IAB) is an interactive visual and auditory education material which is basically intended to improve hand-eye coordination, increase attention duration, and decrease reaction time. IAB is intended to remedy the deficiency of current educational materials used to augment the hand-eye coordination of individuals with certain disabilities, namely Attention Deficit Disorders/ Attention Deficit Hyperactivity Disorder (ADD/ADHD), particularly Mental Retardation (MR) and Autism. IAB development has been highly motivated by a disabled individual who is referred to by the alias 'BoyXY' to protect his privacy.

BoyXY is a person with severe mental retardation who can understand simple sentences, but whose verbal communication is limited to a very small number of words and sounds. He enjoys physical activity and social communications, and he can express himself using body language. However, his concept of communication is mainly limited to hitting and hugging others, throwing objects, touching the other's genital organs, and rushing to other's ears. In fact, this kind of behavior is attention-seeking to gain the attention of others (he simply wants them to perceive his attraction). Because of his preference for stimulus/response for communication, BoyXY is extremely interested in the IAB.

The main purpose of the study is to develop a new tool according to BoyXY's educational requirements and so disabled individuals. At the early stages of the study, BoyXY's educational development was very slow, because his perception was very problematic and his attention period on a certain subject was too short. In addition, he was interested in only a number of activities and he was worried quickly. Since the learning process would be satisfied if attention during certain time of period on a subject which is desired to learn is satisfied, several objects and subjects that BoyXY is interested in for long periods have observed. Main activities and games in IABS were inspired by activities which excites BoyXY and which are likely take BoyXY's interests.

Furthermore, BoyXY was an inspiration individual for the study, and the study developed according to many different disabled individuals who have attention problem. Finally, the tool proposed in this paper aims to improve attention period on a certain subject, hence, to augment the educational development.

2. LITERATURE REVIEW AND MOTIVATION

Many different aspects of hand-eye coordination has been studied over the years including assessing the attention period, increasing the reaction speed, understanding the relationship between reaction and visual stimulus. In addition, there are various researches on attention deficit disorders (ADD) and attention deficit hyperactivity disorders (ADHD). ADD/ADHD is a neurobehavioral disorder that interferes with a person's ability to stay on a task and to exercise age-appropriate inhibition (cognitive alone or both cognitive and behavioral). Several symptoms of it can be listed as: failure to listen to instructions, fidgeting with hands and feet, leaving projects and having trouble paying attention to and responding to details (NINDS, 2007). While a number of the studies have attempted to understand the common causes of ADD-ADHD and to find a way to decrease ADD-ADHD in children and adults, others have focused on developing treatment tools. This section reviews the literature regarding hand-eye coordination, ADD, ADHD and technology tools developed to improve hand-eye coordination and to treat ADD-ADHD.

Much research into ADD and its effects on the human life has been conducted, and the critical importance of ADD and ADHD has been perceived in education, particularly in special and primary education. A recent study has attempted to explore the characteristics of children who sustained injuries as a result of having ADD-ADHD (Badger et al, 2008). They set out to identify and understand the risk factors of injuries, and they searched for ways to educate individuals to protect a repetition of injuries. In a recent paper investigating the role of mind wondering, Smallwood et al (2008) emphasize the human cost of absent mindedness, concluding that "Successful learning requires that individuals integrate information from the external environment with their own internal representations". In their article, they investigate the role of mind wandering play in education.

For many years, ADD and ADHD studies have tried to find a way to reduce ADD/ADHD effects on children and adolescents emphasizing the significance of this problem. ADD and ADHD are severe problems for disabled individuals as well as other children and adults because a number of the multi-disabilities can be masked by ADD and ADHD. Our claim in this research: in order to rehabilitate individuals with multi-disabilities, including ADD/ADHD, it is necessary firstly to deal with ADD/ADHD. In literature, there are a number of studies looking at different aspects of ADD/ADHD, including: economical impact, primary treatment, measurement of attention and related functions, special education policy and practice, time reproduction, working memory, and behavioral inhibition in children, as well as a case study of a 9 years old Latino boy (Pelham et al, 2007; Dupaul et al, 2007; Culpepper, 2006; Mahone, 2005; Prosser and Reid, 2009; Kerns et al, 2001).

In an article, Batista et al (1999) explained that the neural activities regarding visually guided reaching begin with an image on the retina and end with impulses to the muscles. A plan for reaching is constructed at some point during this process. They assumed that this plan is made during the time of the coordinates of the arm, the specifying direction and amplitude of the movement, or in the coordinates of the eye because visual information is initially gathered in this reference frame.

Harris and Wolpert (1998) presented an integrated theory of eye and arm movements, they assumed the neural control signals are corrupted by noise whose variance increases with the size of the control signal. Next, they propose the variance of final eye and arm position depends on the presence of noise in neural control signals. Fischer and Weber (1993) investigated the reaction time of men and monkeys, combining previous research's "special emphasis on the express saccade" with experimental evidence in an oculomotor to improve their understanding of the coordination of vision, visual attention, and the eye movements. Finally, they proposed a neural network structure that was able to function as a basis for a mathematical model or computer simulations of the optomotor system in primates. The main concern of these articles was strong relation of saccade reaction and hand-eye coordination with brain activity. Another study concludes that there is an anatomical relationship between the parietal and the frontal cortex in hand-eye coordination during reaching movements (Marconi et al, 2001).

Another piece of research entitled "From eye to hand: Planning goal-directed movements" by Desmurget et al (1998) emphasized the lack of understanding of the nature of the neural mechanism required in movement planning. In this study, the target localization, definition of the initial state of the motor apparatus, and hand trajectory formation were identified as main tasks that the nervous system needs to manage. In addition, they addressed a number of issues regarding the main tasks before finally suggesting that the central nervous system was able to use different strategies both to encode the target location with respect to the body and to plan hand displacement. In their study, Johansson et al (2001) analyzed the coordination between gaze behavior, fingertip movements, and movements of the manipulated object in a target-switch pressing exercise. They conclude that they made a decision on that gaze supports hand movement planning by marking key positions to which fingertips or grasped object are subsequently directed.

Vercher et al (1994) studied the execution of an accurate pointing response, investigating the dependency of this response: whether it depends on a prior saccade orientation towards the target or is independent of the view of the limb. The resultant saccadic eye fixations are quite perceptive behavior understanding much more things about the cognitive mechanism which guide them (Ballard et al, 1992). In the literature, there are numerous recent studies focusing on the examination saccadic responses, interaction with objects, gaze influencing finger movement and visual activations, parietal reach activity, gaze behavior in reaching to remembered targets, sensorimotor accounts of drawing, performance errors and vigilance level, hand-eye coordination of elderly people, arm movement and saccade metrics, and retinal image location of hand (Pratt and Neggers, 2008; Yoshida and Smith, 2008; Bedard et al, 2008; Buneo, 2008; Flanagan et al, 2008; Cagli et al, 2008; Dorokhov et al, 2008; Pei et al, 2008; Kattoulas et al, 2008; Timberlake et al, 2008).

Our study has been based on BoyXY's educational requirements and the idea "when a peripheral visual stimulus is briefly presented in an empty surround, and an observer is required, after a delay of a few seconds, to point toward the remembered location of that target, the responses are strongly influenced by eye orientation at the time of pointing" (Enright, 1995). This present study aims to develop a new tool (combination several hardware tools) and related software with the assistance of emergent technologies improve attention and hand-eye coordination.

A number of materials and tools which are used to improve hand-eye coordination and visual attention have long been in use and some examples can be found in Table 1. The materials and tools listed in the table have several advantages such as ease of manipulation by educators, low cost, high availability, and low maintenance because they are not dependent on emergent technologies. However, with the exception of computer games, most are not interactive, the interaction is supplied by trainer or educator. In addition, many of them are not developed for individuals who need special education. Moreover, computer games developed to improve hand-eye coordination require ability to use mouse or keyboard, and therefore are usually unsuitable for special education because many of disabled individuals lack the capacity to use these kinds of computer peripherals.

Table 1. Some existing materials and tools being currently used to improve visual attention, hand-eye coordination

Material/Tool	Goal
Visual education attention card sets	Improve visual attention
Simple pictures with compositions	Improve visual attention
Paper work with geometric figures	Improve visual attention, Improve memory
Tread and color beads	Improve visual attention, Hand-eye coordination Activation attention
Short and simple texts	Improve auditory attention
Balloons	Improve visual attention, Hand-eye coordination Improve concentration
Memory cards	Improve visual attention, Improve memory
Nail Legos and grid	Improve visual attention, Hand-eye coordination
Animal voices and cards	Improve auditory attention, Improve memory
Nail board	Hand-eye coordination
Roly-poly rope	Hand-eye coordination, Improve attention in fine-motor activities
Puzzles	Improve visual attention, Hand-eye coordination
Sudoku (with images) easy to hard	Improve visual attention, Hand-eye coordination
Line drawing activities	Hand-eye coordination
Pattern completion	Improve visual attention, Hand-eye coordination
Neural-Feedback applications	Improve visual attention, Improve concentration
Computer games (complicated)	Improve visual attention, Hand-eye coordination
Computer games (simple)	Improve visual attention, Hand-eye coordination

Numerous ADD/ADHD treatment and assessment methods developed for both academics and commercial purposes have long also been in use. These methods offer various approaches to remedy ADD/ADHD problems, such as stimulant medications techniques, worksheets and programs, educational software, generic strategy developments, reading-writing exercises, reminders, electronic agendas (Newideas, 2009; MyAdhd, 2009; Lund & Lund, 2008; Parker, 2009; Addcoach, 2009; Teach ADHD, 2009; Miranda et al, 2002; Rabiner & Coie, 2000; Reid & Lienemann, 2006; Baker et al, 2003; Northup & Gulley, 2001; Sahin, 2006). Although almost all of the reviewed studies have attempted to treat ADD/ADHD, none of them offers an interactive improvement tool for individuals with disabilities, particularly individuals with MR or Autism.

This paper explains the development of an Interactive Attention Board (IAB), drawing on previous research and theoretical work. IAB can be effective in improving visual attention and hand-eye coordination for individuals with disabilities especially mental retardation and autism. Since the IAB is a complementary tool for non-interactive educational materials in special needs education, the basic principle of IAB is to improve quality of training using technological equipment and computers. Because IABS has been developed in computer environment, as well as supporting interactivity the computer software facilities can be used for many additional purposes such as storing individuals' information, training data, and trends. Moreover, IABS also enables comparison of previous training data with current results, therefore, creating the opportunity to assess and evaluate individuals' improvements over time.

The human brain has a strong tendency to organize different stimulants as objects which contrast with a certain background. There are a number of important factors to identify what can be perceived such as attention, preparatory set, motivation, sensory depravation and learning. In addition, factors which affect perception can be divided into two main categories: the features of the stimulus and of individual who perceives (perceiver). The first factor which can affect perceptional selection is change in stimulus (used by many advertising company to increase advertising effectiveness), other factors include repetition, size intensity. In the aspect of individual, expectations, interests, needs, beliefs and individual values are other factors which can affect perception (Cuceloglu, 1991:122; Morgan and King, 1971; Morgan, 1995). Factors which affect the perception are illustrated in Figure 1. These all factors and theories were taken into account during IAB system specification and design.

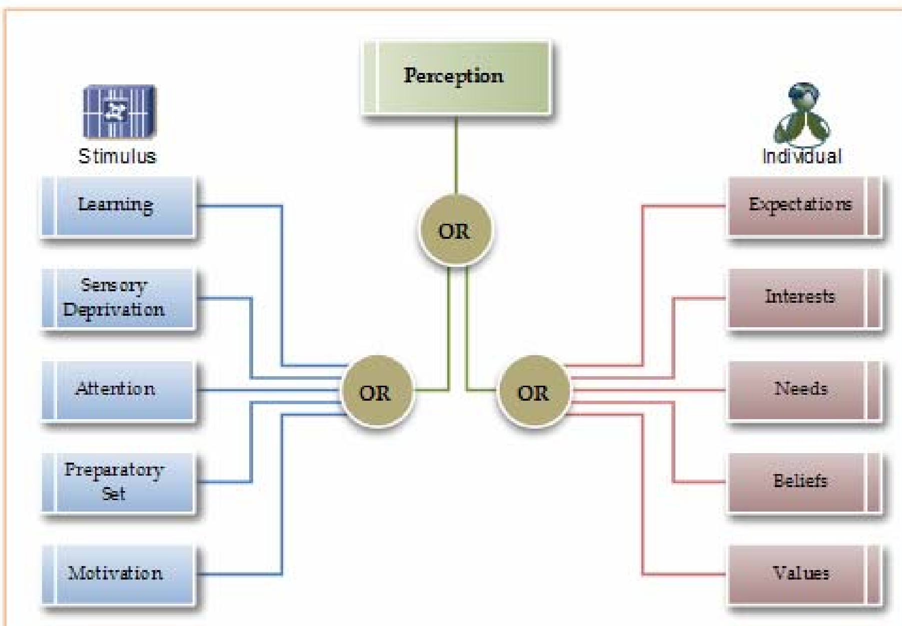

Figure 1. Factors that can affect the perception

3. INTERACTIVE ATTENTION BOARD (IAB)

Basically, IAB system is a very simplified interactive tool which can be used to improve attention duration. The main features of IAB simply are:

1. It provides very simple user interfaces especially for disabled individuals, and it has no complicated data presentations.
2. Rewards of the IAB in case of achievement of a certain task can be selectable by teachers, thus the teachers have a chance to select most appropriate digitized rewards (voice, picture, animation etc.) from their repository (previously used or new) for each individual.
3. Each individual can be monitored distinctly.
4. Since all the responses (wrong, correct, omitted) are stored in database separately, in case of any request they can be easily used for statistical analysis or tracking the individuals' improvement.
5. No training is required for individuals (training is required for teacher).
6. Because of its adaptability, portability and simple structure, it can easily be reproduced using any of computer programming language on various hardware devices.

7. Because of the system's compact and flexible design, new features can easily be added such as digital version of existing materials presented in table 1.

Moreover, IAB is based on various theories about factors that can affect perception, such as attention theory, intensity and size, contrast, repetition, and movement of stimulus and objects. IAB consists of target and reward stimulant figures, videos and pictures, various animations, educational features enhanced with database applications to assess individuals' improvements. Although IAB has been developed for use in special education, especially for individuals with severe and moderate mental retardation, and autism, it can also be used to improve hand-eye coordination and auditory reactions of kids and individuals with mild mental retardation and ADD/ADHD. Furthermore, it can be an effective alternative to conventional class materials in childhood education.

In ADD/ADHD therapies, various types of trainings activities are used, such as perceiving the details of objects or environment, remembering previous works, aligning objects and subjects, increasing reaction speed through games, and finding the appropriate reinforcement and using them in the relevant place and time. However, there are not too much training policies or standards or materials for target group in special education. We believe that IAB can be a complementary tool to existing training activities to improve attentions of individuals with autism and MR.

3.1. Interactive attention board software (IABS)

Figure 2 shows the use-case diagram of Interactive Attention Board Software (IABS). IABS consists of 5 main use-cases:

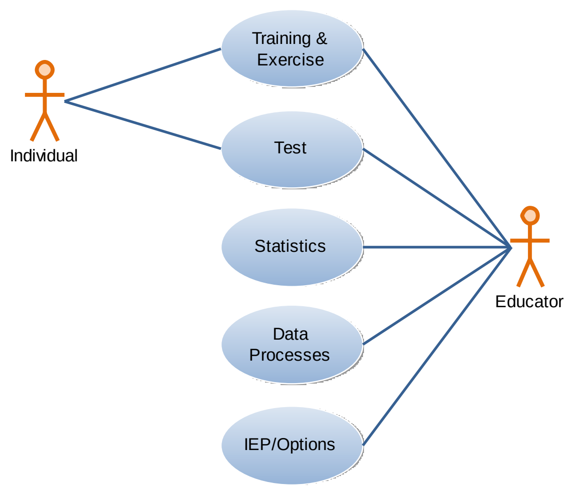

Figure 2. IABS use-case diagram

a. Training/Exercise

In this case, many different attention-exercising tests are applied to prepare the individual for each test stage. The details of this exercising will be given in the operational details section.

b. Test

The real test environment is established for the assessment and education of individuals, and all data gathered from an individual's test are recorded.

c. Statistics

In the statistics case, the individuals' test results are compared, individuals' improvements or regressions are shown graphically, and reported.

d. Data Processes

In data processes unit, database operations are managed.

e. Individual Education Plan (IEP)/Options

In this section, personal information of individual and educator are manipulated. Moreover, the special personal requirements and identifiers of individuals (trainees) are also recorded such as rewards, appropriate colors, sounds, etc. In addition, the Individual Education Plans (Goals, objectives, behaviors) are also identified in this section.

3.2. Operational Details of IAB

The educator (trainer) and special needs student (trainee) sit together in front of a LCD screen with a touch screen feature. Figure 3 demonstrates the IAB system illustration,

Figure 3. An illustration of a training session of IAB

In the first execution of IABS, the educator should record the individual personal information and set up options related to the disabled individual such as, age, diagnosis, training type, goals. After choosing these initial settings, IABS is ready for training sessions.

3.3. Training/Exercising and Test
3.3.1. For Disabled Individuals with Moderate and Light Mental Retardation

The scenario used for both exercising and testing is illustrated in Figure 4. This scenario is based to perception theory. Firstly, the screen is filled with blurred and mat colored object (size, color and blur level of object vary in accordance with the individuals' options identified by educator as individual personal requirements in IEP/Option section, in this scenario a rectangle was used, however other objects can be used and sample object can be seen in Figure 5), and educator starts the exercise. Next, a rectangle is flood filled with bright red, and then active stimulus starts to move, leaving gradient trace on rectangles at a speed of 10 rectangles/second. After each 10-15 rectangles are activated and traced (the number of rectangles depend on size of the screen), the active stimulus direction is changed to up or down. After 3-4 seconds, the active stimulus stops, and starts to blink until the individual touches it. This process is intended to attract the individual's attention according to perception theory. The educator asks the individual to touch the active stimulus, and assist physically individual to touch the object if necessary. When the individual touches the active stimulus, the object fits to screen (fill the whole screen), and a reward (both visual and auditory) stimulus appears on the screen for 5 seconds. For every target stimulus touch, a different reward stimulus or sequence of rewards should appear. According to an individual's characteristics different kinds of reward stimulus can be identified by educator, such as a picture of the individual's mother, favorite toy, item of the clothing, or a cartoon character. Sample reward stimuli can be found in Figure 6.

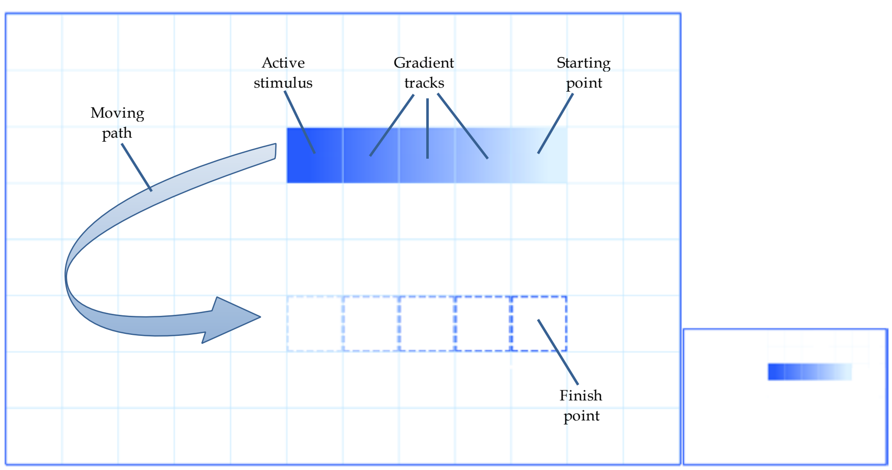

Figure 4. Tracking and touching schema (left side for use-case description, right side for its exact appearance)

Figure 5. Sample active stimulus objects, these objects can also be used as rewards

Figure 6. Sample rewards which can be used to promote individuals

After a reward stimulus disappears, the active stimulus reappears within 0.5 second, and the training continues. If the individual touches a wrong point while training, the active stimulus disappears for five seconds before reappearing. After a number of exercises on the same stimulus, the educator relinquishes the physical assistance, and only indicates the stimulus, and asks the individual to touch it. After a while, only verbal assistance is given by the educator. This period continues until the individual touches the active stimulus independently. When independent attention is achieved on the stimulus, the educator asks the individual to touch the stimulus (such as a game or a competition environment) as fast as possible to improve reaction time to the stimulus.

After exercising on the initial training, the test stage is able to be applied. In the test case, the educator and individual sit front of the LCD as well as exercising mode, and test is started. At the beginning, the educator reminds the individual to touch the correct stimulus (active stimulus) immediately when it appears or stops (it depends on the test type). The educator does neither assist the individual physically nor verbally during the 60 tests. In the first ten, the stimulus blinks for five seconds, in the second, for four seconds and so on. During the test study, all the data about the individual, such as reaction time and wrong/correct touches, are recorded (This test data will be compared to next test data).

3.3.2. For Disabled Individuals with Profound and Severe Mental Retardation

In the case of testing an individual with profound and severe mental retardation, the exercising and testing should be simplified. In the first stage, a bright red rectangle fills the whole screen and blinks slightly. A touch at any location on the screen in five seconds is to be rewarded. In the early stages of this training, the educator acts as model (showing how a touch can be made) and shows before asking the individual to touch the screen. If the trainee shows no willingness, the educator assists the individual with verbal, visual or physical assistance. This process is applied five times.

In the next stage, the size of the rectangle is reduced to 1/4 of the screen size and continues blinking. Figure 7 demonstrates this scenario. Any touch at any red region on the screen is rewarded for 5 seconds. Meanwhile, the rewards in this training can also be selected from previously identified rewards meaningful to the individual. If the individual shows no willingness, the educator assists the individual with verbal, visual or physical assistance, as in the first stage. In this stage, the individual performs this application five times. In the third, the similar procedure is applied five times but with a reduced rectangle (1/8 of the screen) and the same assistance is given at this stage.

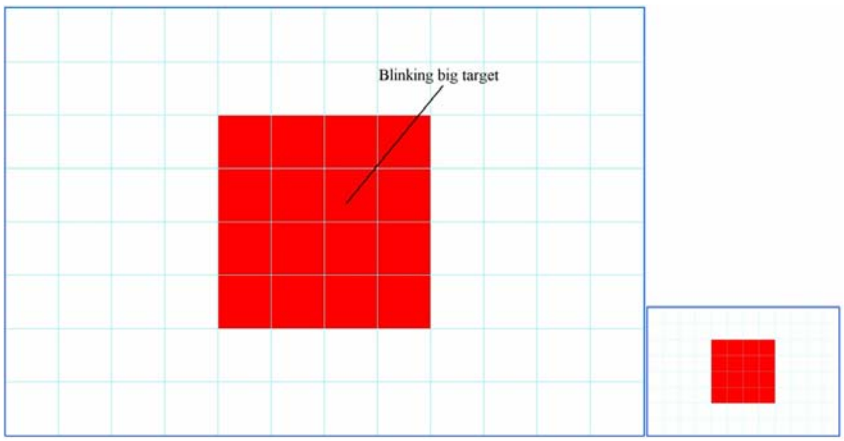

Figure 7. Perceiving and touching schema (left side for use-case description, right side for its exact appearance)

In the test stage, the educator and the trainee are front of the screen which is divided into two different colored rectangles, each 1/16 the size of the screen, white for the educator and red for the trainee (colors can be changed if necessary), however none of them appears initially. Firstly, the white rectangle appears for the educator who touches the target stimulus in the educator side causing the rectangle to expand to the whole screen flash, and then a reward object appears for five seconds. Second, the rectangle in the individual's side appears as a target stimulus. When the individual touches the stimulus on the screen, the red rectangle expands until it eventually fills whole screen and flashes, and then a reward object appears for five seconds. This application is repeated until the individual perceives the stimulus. When the trainee's achievement in perception is quite satisfied, previously divided screen is integrated and the whole screen is left to the individual.

During all exercises and testing studies, the educator encourages the individual with certain words such as "Look at, there is a light here, and I touch that light. Ooooo, do you see what a beautiful object", "Yes it is your turn, the red light, come on catch it immediately" etc.

Many other test types provided by the IABS, such as testing for touching single stimulus, tracking stimulus, moving stimulus, touching dual stimulus with both hands etc. IABS also offers some additional tools for explaining certain concepts:
-Space set (The Sun, The Earth, Moon, Comets, Planets, etc)
-Wild animals set (Lion, Bear, Elephant, Snake, etc)
-Aves set (Eagle, Hawk, Chicken, etc)
-Marina animals set (Whale, Dolphin, Penguin, Fishes, etc)
-Dino set (T-Rex, Brontosaurus, etc)
-Profession set (Lawyer, Doctor, Teacher, Engineer, etc)
-Vehicle set (Bicycle, Motorcycle, Automobile, Truck, etc)

3.4. Data Gathered During Test and Assessment

A number of data is gathered from the tests to be used for assessing the improvement of the individual, and recorded in a form of individual tuple on the database. Table 2 shows the tuple structure for a single training.

Table 2. Individual training data structure

Data	Description	Unit
Individual_Id	Individual who oversees the test	String[11]
Test_Id	Test type which is applied	Integer
Test_Scenario	Test style which is chosen from the options	Integer
Test_No	Test number in the test period	Integer
Response_Type	How the individual's responded the stimulus	[Omitted/Correct/Wrong]
Response_Time	Individual's reaction time	m-second
Date/Time	Time of training	Date-time

In the table, Test_Scenario field is used to identify the test style which can be identified in options according to individual's special needs and includes features, such as reward type, object type and colors. This is very useful for determining the optimum conditions for test environment for the individual's comfort and convenience.

The data listed in Table 2 and 3 are obtained and stored during individuals' trainings, and they are used to create reports about individuals' training session by session, percentage of improvement on attention etc. Using each individual' training data, a number of statistics can be generated for several features, such as assessment and evaluation of an individuals' improvement. Moreover, the data listed in Table 3, IABS enables current statistical results to compare with previously computed results.

Table 3. A number of statistics which can be generated by IABS

Statistic Type	Unit
Which test is trained by the individual	String
Total number of the wrong responses (touching wrong locations)	Integer
Total number of the correct responses (touching correct locations)	Integer
Total number of the omissions (non-response)	Integer
Total number of the correct responses (with physical/verbal/visual assistance)*	Integer
Total number of the correct responses (independent) *	Integer
Average reaction (response) time for wrong responses	msec
Average reaction (response) time for correct responses	msec
The fastest reaction (response) time for wrong responses	msec
The slowest reaction (response) time for wrong responses	msec
The fastest reaction (response) time for correct responses	msec
The slowest reaction (response) time for correct responses	msec
Average achievement (percentage of perceiving the stimulus)	%

* optional

Using these data, individuals' improvements can also be illustrated in form of several graphics which can be used to assess and evaluate the individual's current status. As well as individual level, this data can assess groups of individuals having similar disabilities. Although it is unlikely that two individuals would have exactly the same type and level of disability, statistical data for ADD/ADHD may be able to provide interesting comparative trends using these data.

4. BOYXY: A CASE STUDY

BoyXY has completed 11 training sessions with IABS. The first session was in exercise mode, remaining sessions were test studies. Each session includes 60 independent tests (trainings) and takes approximately 15 minutes. After each session of IABS, BoyXY returned to his normal education, which is identified by an individual education plan. In addition, no assistance was given to BoyXY except in the first session, he has, therefore, completed 10 sessions independently.

The teacher's expectation for improvements of BoyXY's attention and results giving BoyXY's continuous attention durations for several different types of activities, before and after 660 IABS trainings in 11 sessions are shown Table 4.

Table 4. BoyXY's continuous attention durations on several activities before and after 660 trainings with IAB and teacher's expectations

Continuous attention required activity	**CAD* (minute) Before**	**CAD* (minute) After**	**Total Improvement**	**Teacher Expectation (face to face)**	**Improvement (Contribution of IAB)**
Books with illustrations	3	5	67%	33%	34%
Books with illustrations	5	7	40%	20%	20%
Books with music	5	8	60%	50%	10%
Puppets	2	6	200%	100%	100%
Computer game**	30	22	-27%	15%	-42%
Listening to the educator	6	7	17%	15%	2%
Painting	6	7	17%	15%	2%
Chatting with the educator	2	3	50%	50%	0%

*CAD (Continuous attention duration)
**In this activity, sometimes the educator is required to hug and kiss BoyXY for 1-2 seconds
***In this activity, the educator is rarely required to warn BoyXY

Figure 8, Figure 9 and Figure 10 show BoyXY response types, response (reaction) times and fastest and slowest responses to the stimuli respectively during 11 sessions (totally 660 trainings).

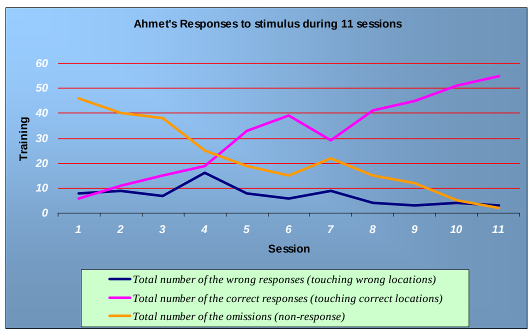

Figure 8. BoyXY's responses to the stimuli during his training

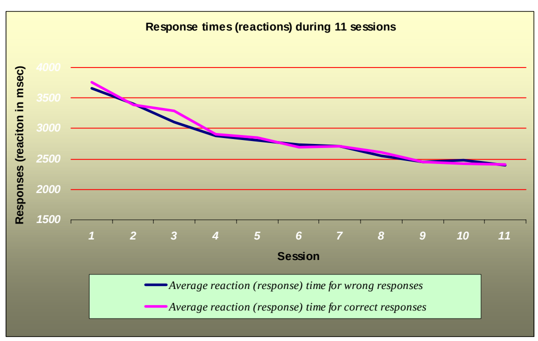

Figure 9. BoyXY's responses times to the stimuli

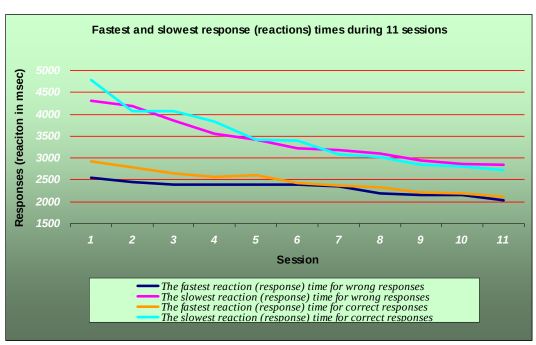

Figure 10. BoyXY's fastest and slowest responses to the stimuli

Table 4 shows certain improvements of BoyXY's attention duration in a number of activities. As a result, the effect of IAB is reasonable, however, his attention period decreased in computer games. Possible reason for this decrease may be the changes in BoyXY's expectations from the computer, and we think that BoyXY still expects a reward to appear on the computer screen. Since, IAB training is supported by face to face (F2F) training (typical training), improvements of BoyXY's attention are results of IAB and F2F trainings together. In addition, the educator notified that "IAB has assisted to increase BoyXY's attention duration, hence level of improvement was reasonable and it made BoyXY have fun". Moreover, Figure 8 shows that he achieved a remarkable improvement on correct stimulus perception, and Figures 9 and 10 demonstrate the improvements in his response times to the correct stimuli objects. In addition, his IEP trainers informed that they have observed improvements in both BoyXY's hand-eye coordination and attention duration after his IAB trainings. The results of this case study show the improvements on attention and hand-eye coordination only for the case of BoyXY, thus the same improvement levels may not be obtained from trainings of all the individuals with same or other disabilities.

5. CONCLUSIONS

This paper presents a new technological tool IAB that can be used to improve hand-eye coordination and attention duration of individuals with certain type of disabilities, particularly MR and Autism. Using the IAB system, a case study has been conducted, and an individual with severe MR has completed 11 IAB training sessions. The results showed that very impressive improvements in eye coordination and reasonable level of improvement in attention duration of the individual were obtained using IAB system. In fact, it is not possible to say with certainly that this system can attain the same level of improvement for every disabled individual, because it is unlikely that two individuals in special education would have exactly the same type and level of disability. However, this system can be used in special education for augmenting the ADD/ADHD treatments and hand-eye coordination, and statistical data gathered from the system may be used for a range of different purposes, such as comparing individuals with similar disabilities, and comparing the achievements of an individual over a period of time.

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