Employing virtual reality for aiding the organisation of autistic children behaviour in everyday tasks

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ABSTRACT

This paper documents part of a research project under the title: "Computer-Assisted Education and Communication of Individuals with Autistic Syndrome", which aims at designing and developing computer-based environments for aiding the education and assessment of autistic children. The theoretical basis of the project is explained. Finally, a scenario titled "Returning Home" for a virtual reality application, which would aid educators in organising the behaviour of autistic children in a series of everyday activities, is described.

1. INTRODUCTION

It is widely accepted that autistic children perceive the world and human behaviour in a unique manner. Autistic perception is governed by an idiosyncratic way of processing information. Most therapies and educative methods aim at being more effective by adjusting and meeting the specific needs of "autistic" understanding. Some of these needs make the use of virtual reality technology more relevant to the education of autistics.

One of the hypotheses about the phenomenology of the autistic syndrome is that autism derives from a lack of coherence in the processing of new information (Frith, 1989). The main difficulty of autistics is in understanding higher human mental activities, like expression of emotions, motives, beliefs and intentions, ultimately resulting in disabling communication. Therefore, the lack of coherence and the fragmented perception of autistics could justify characterising the world conceived by them as "*virtual"*. In this sense, it could be hypothesised that if we present autistic children with a *"virtual"* world, appropriately designed and adapted to their individual manner of conceiving reality, we may aid them in processing information and functioning accordingly.

This paper documents part of a research project under the title: "Computer-Assisted Education and Communication of Individuals with Autistic Syndrome", funded by the General Secretariat of Research and Technology of Greece and coordinated by the Department of Informatics, University of Athens. The aim of this project has been to design and develop computer-based environments for aiding the education and assessment of individuals with autism. An additional objective of the project has been to develop a web site for disseminating information and for aiding communication amongst professionals, parents and autistic individuals themselves.

Firstly, a literature review covering a range of issues regarding autism, including current ways of understanding at a biological and psychological level as well as educational – therapeutic approaches took place. At the same time, related computer-based environments for aiding autistic individuals were also reviewed. This phase led to a series of conclusions, which formulated the basis for this project, some of which are discussed in section (2) of this paper. Secondly, a pilot study took place for the purpose of testing the use of computer-based tools on children of this target group. This phase aimed at recording the responses of a range of autistic children to the use of such tools and is described briefly in section (3) of the paper.

Conclusions and observations from these two phases were taken into account in the design of a scenario (section (4) of the paper) describing in detail the exact sequence of events and consequent requirements for an interactive application that would aid the organisation of autistic childrens' behaviour in everyday activities. Finally it is suggested that virtual reality technology would be ideal for bringing this scenario to

life. As this project is currently at its development phase, an indication of what has been achieved so far will be presented here.

2. COMPUTER-BASED LEARNING FOR AUTISM

The unique ways in which autistic individuals think and learn provide support for the view that the use of computers in aiding the learning process of these individuals will have many advantages. More specifically, Murray (1995) has suggested a list of characteristics provided by computer-based systems, which suit well the structured educational needs of autistics:

- clear boundaries
- controlled and step by step presentation of stimuli
- simple and obvious connection of information processed though one channel
- facilitating joint attention by selecting a compatible focus of interest
- restrictive context
- instilling feelings of safety, flexibility, adaptability and predictability of the learning environment or material
- enhancing development of autonomy, encouraging communication, boosting self-confidence and reinforcing optimism and respect.

Possible dangers involved in the use of computers for autism have been also discussed. These potential dangers can be compensated for by the appropriate incorporation of computer-based tools into a specifically organised teaching approach. It is not clear whether one could expect transfer of existing computer-based learning applications for autistic children to real world conditions. Similarly, placing such an application within an appropriate teaching context increases the possibility of achieving transfer of acquired knowledge to real world situations and consequently of enhancing generalisation (Jordan, 1995).

Taking all of the above into account, many aspects of effective learning can be promoted. In fact, several studies are in favour of the effectiveness of computers for educating autistics (Jordan & Powell, 1990, Heimann et al., 1995, Murray, 1995). The autistic child's involvement in the use of such a system may also become enjoyable without distracting from the learning target.

Virtual reality (VR) technology has already been successfully used in the treatment of phobias and in interventions to individuals with special needs. With reference to the autistic syndrome, Strickland et al. (1995) and Strickland (1997) have identified a series of VR technology characteristics, which justify its use by autistics:

- Immersive VR can isolate autistic individuals from their surroundings in order to help them focus on a specific situation.
- The complexity of a scene can be controlled.
- The lag of a VR system may not necessarily be problematic for an autistic; on the contrary it may prove useful towards aiding learning processes.
- VR technology allows for the successive and controlled adjustment of an environment with the aim of generalising activities at different but similar settings.
- A learning VE can be realistic, easily comprehensible and at the same time less hazardous and more forgiving than a real environment, when a mistake is made by the user. Thus, a VE provides us with a safe and controlled setting for developing skills for everyday life activities.
- The thought patterns of autistic individuals are mainly visual and a virtual environment (VE) builds on this specific visual skill.
- The present state of VR technology focuses on visual and auditory instead of haptic or other sensory stimuli. Specifically for autism, vision and hearing have proven to be very effective in the development of abstract concepts (Jordan & Powell, 1990).
- The use of tracking devices affords the possibility of monitoring the activities of an autistic, allowing for a re-adjustment of the system according to user's responses. Since a significant percentage of autistics never learn how to communicate, such a system may afford the possibility of interaction with simulated environments without verbal guidance provided by educators.

These characteristics correspond to the above mentioned list of factors for an effective educational system for autistic children. Moreover, a limited set of experiments (Strickland et al., 1995) have shown an encouraging adaptation of a small number of subjects to an immersive VE. This technology offers the ability to control and adjust a synthetic environment and this may prove useful for matching the needs and expectations of autistic children and consequently for teaching autistics how to respond to real world events and situations. However, more research is needed for establishing whether autistics can generalise the learning results achieved through interacting with different types of VEs.

Finally, it has to be stressed that "a gap exists between those who know about autism and the right questions to ask and those who know about the information technology and might come up with some of the answers" (Jordan, 1995). There has not yet been any computer-based application specifically developed for the autistic population in Greece. This project aims at being a first step towards this direction. It is important to mention that the team of individuals collaborating in this project consists of both people who specialise in autism and those who specialise in information technology.

3. PILOT PHASE OF THE PROJECT

The pilot phase of the project consisted of the following stages:

- A series of different types of multimedia learning environments were selected
- Educators of autistic children were trained during an intensive course into using these learning environments
- A pilot study took place in the specialist centres that collaborate in this project (EKAP, Pamakaristos) under the supervision of the trained educators
- The educators recorded their pupils responses to the selected learning environments in a specially prepared assessment sheet and were also encouraged to freely report their own impressions regarding the overall process. This fact was of particular importance since for most of them it had been their first experience of using such a tool in an educational process.

A sample of approximately 20 pupils, who had been officially diagnosed as autistic and with different levels of functioning, participated in the pilot phase.

4. "RETURNING HOME" A SCENARIO FOR EDUCATING AUTISTIC CHILDREN IN EVERYDAY TASKS

4.1 Background to the scenario

The essence of autism as a developmental disorder lies in the uneven and characteristic pattern of developmental psychological abilities, which results in an unusual combination of weaknesses and strengths. An educational program may be based on the existing areas of strength and could aim at enhancing weaker areas for the purpose of improving the overall level of functioning of the person.

The relationship between an autistic person and a non-autistic individual could be described through the metaphor of a wall, which is often being raised between them. Autistic children discourage people who try to relate to them because they do not adapt to their habits and wishes and because they rarely disrupt the regularity of their own persistent interests. One very important consequence of this behaviour is the disruption of learning even the most basic everyday activities like eating routines, washing and dressing in a consistent way. It is even more difficult for them to represent these activities. Additionally, they do not feel the need for imitating daily activities while playing.

Verbal communication is limited and as a result autistic individuals cannot easily comprehend spoken language or pay attention to the language addressed to them, while their comprehension is limited to a concrete understanding of things. It is therefore understood that their educator cannot be supported by spoken language and dialogue for teaching useful activities and enhancing their behaviour.

These facts have led to an identification of alternative ways of communicating in combination with addressing the children's stronger areas of functioning, like visual perception. Autistic children have accurately been characterised as "visual learners". In this respect, the use of symbol-cards (or icon-cards), within a structured educational context, has proved to be very useful in overcoming certain difficulties. Whenever language understanding fails to support communication, the symbol-card along with its inherent

rules offers an alternative way of "speaking": simple, unambiguous and specific. As a result, the autistic children's communication with their environment may be compensated to a certain extend.

The use of the symbol-card helps children feel comfort and even pleasure after making the effort to respond to what the card presents. The icon displayed on the card is carefully designed so as to visualise the meaning of spoken language in the best possible manner. It helps autistic children feel safe and express themselves verbally, when possible. When children are not capable of speaking, they can express their needs through a card. The use of symbol-cards during playing or other activities seems to also have rewarding results for the promotion of speech and independent performance during activities.

The well known and widely accepted TEACCH program approach incorporates the use of visual representation of things and events including symbol-cards and places them in discrete sets of sequences, thus providing good support for the above mentioned views.

4.2 Description of the scenario

According to (4.1), a scenario under the title "Returning home" was designed in the form of a simulated environment addressing the visual perception of the child. The aim of the scenario was to provide the educator with a tool, which would improve his potential for effective teaching. More precisely, the content of this scenario could help him achieve a coherent organisation of certain important everyday activities, provided that it is appropriately incorporated within an overall teaching strategy.

In fact, "returning home", including the use of cards but in its non computer-based form, is a scenario which has been used in recent years, in everyday practice with autistic children. Through our direct experience with this scenario, it has been evident that children respond well and acquire a better understanding by making use of this approach. In search for a potentially successful "returning home" scenario in a computer-based form, the significant issues of using symbol-cards, speed of presenting information, quality of colour and sound, coupling of icons and corresponding words and several other aspects were addressed by the design team. The symbol-cards used in this application are the MAKATON symbol cards, which were provided to the project by the "Makaton Hellas" official representative.

The points, which were specifically taken into account while designing the scenario for the exercise, were the following:

1. Symbol-cards should precede each presented activity so that autistic children may focus their attention and understand a series of everyday life routines like eating, dressing, sleeping etc.
2. Special attention was given to the order and speed of presentation. It has been observed that autistic children respond better when a series of events follows a certain order and when the speed with which these activities are presented corresponds with their own individual rhythm. This may rid autistic children of the stressful and chaotic behaviour by letting them know of what will happen next. The symbol-card and the appropriate point of presenting this card are always crucial for the proper execution of the exercise.
3. The colours, which surround the presented images, are pastel and continuous. They should not be very vivid as this would call off their attention and would seduce them into non-functional stimuli.
4. Autistic children perceive sounds in a very special manner. While they may not respond to a person speaking to them at all, certain not very significant sounds may easily draw their attention. In cases of children with advanced musical education, music does not seem to have an enjoyable effect on them but is simply perceived per se. Therefore, any auditory enhancement of the interactive system should be very carefully designed with the aim of activating the children but without upsetting them.
5. Specific care should be taken into writing words, either in the form of icon labels or as stand alone signs, since the «literal» mind of autistic children may make them focus on one of these words and, without interpreting the correct meaning of the word, lead them to a wrong choice of action. There is also a danger that a label under an icon may distract from the icon itself or trap them into one single letter of a word. It is therefore important that icons are relatively abstract and unambiguous.
6. Re-enactment can be seen as a method of playing. Since the mind of autistics is «literal» and lacks imaginative thinking, playing activities should also be taught. Inherent in this difficulty is the fact that autistics cannot easily distinguish between the real and the imaginative. A way of achieving this could be through clearly determining the boundaries for a certain sub-space, within which imaginary events and activities are allowed to take place. Real world events take place outside this sub-space, thus clarifying the concept of «reality» for the autistic child.

These points were seen as requirements for the application to be designed.

This application aims to be another tool for aiding the very difficult task of educating autistics. The scenario will be implemented in an individualised one-to-one base. Therefore, this tool should be somehow adaptable to the individual's level of functioning and consequent educational needs. In order to achieve such an adaptation, the application would have to provide the educator with the opportunity to:

1. Select between two modes of functionality (A and B), corresponding to individuals with a lower level of functioning (A) and to individuals with a higher level of functioning (B).
   - The former mode is relatively passive involving the individual only in pressing a button for triggering the next sequence of activities.
   - The latter mode is relatively more active, involving the individual into navigating within the simulated environment and interacting with specific 2D or 3D objects in a constrained manner.
2. Select amongst a series of certain sequences of activities to be presented to each autistic individual in a certain order.

The application presents autistic children with possible everyday activities that may take place when a child returns home. They are able to navigate within this virtual environment, follow a virtual character demonstrating these everyday activities and interact with elements of the interface (2D or 3D) in order to trigger certain actions within the scene. After the completion of an activity, a symbol-card prompts the autistic child to act in order to trigger the next activity to be executed.

The entry setting for the application presents the child with an environment, comprising an arhetypal two-storey house and a road from which the virtual character arrives by a school bus. The mother greets the virtual character, who enters the house. On entering, the child is presented with a plain, longitudinal space, from where one can access the 5 rooms of the house where activities will take place: bathroom, kitchen, child's room, parents' room and living room. Each of the rooms has a symbol-card positioned on its door to indicate its function. In mode (B), movement of the virtual character is controlled by the autistic child by making use of an appropriate input device. In mode (A), the child simply triggers one sequence after the other, automatically following the animated virtual character who executes a sequence of everyday basic activities.

Figure 1. *The virtual character demonstrating the activity of "washing hands".*

Following the brief description of the scenario, the appropriate technology for implementing this scenario was identified. This process took into account the degree to which the technology satisfied the requirements described by the scenario. These requirements dictated the design of a three-dimensional environment, within which an animated character could perform a series of activities, the autistic individual could navigate and follow the character in a relatively controlled manner and interaction with certain 2D and 3D interface elements is supported. This environment could only be implemented by making use of VR technology.

5. CONCLUSIONS

The uniqueness of the autistic syndrome and the diversity of its symptomatology has directed the scientific team of the presented paper into designing an explorative, structured environment. Specialist trainers of autistic children urge for the development of parametrical environments, which could be adjusted to each individual case of an autistic child.

Currently the application is at the development stage. After completion, an evaluation will take place, in which a number of autistic children, will participate. These children will have been assessed in terms of their language and learning abilities, as well as level of functioning.

The proposed application is not seen as a panacea. It is understood that it is difficult to find a scenario equally suitable for every autistic child. However, the relatively parametrical nature of the proposed virtual environment application is expected to compensate to a degree for this inherent problem.

At this stage, the proposed environment is primarily a tool designed for aiding autistic children educators at their very difficult task. It is also important to stress the fact that this environment does not aim to substitute existing educational approaches for autistic children but rather to enrich them. Such an application could only be utilised if it is incorporated within the context of an overall educational strategy.

The designed environment implements structured tasks for training, relative to the specific needs of these children and utilises a VE system in order to filter and control environmental distractions, which may negatively affect autistic users. It is anticipated that this filtered environment and the training structured tasks could generate the interest and provoke the engagement of autistic users. With the proposed VE, the trainer could design highly filtered, structured and controlled tasks, assisted with techniques of driven attention and paired with the corresponding communication cards, to match the individual learning needs of an autistic user. In the mean time, certain aspects of this scenario could be utilised for promoting a series of secondary skills, which could also be considered as educational targets.

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