Computer Science and Information Systems 11(2):723–743 DOI: 10.2298/CSIS140215039C

A Novel Educational Game for teaching Emotion Identification Skills to Preschoolers with Autism Diagnosis

Eirini Christinaki[1], Nikolas Vidakis[1], and Georgios Triantafyllidis[2]

[1] Technological Educational Institute of Crete, Dep. Informatics Engineering, Heraklion, Crete
echrist@ics.forth.gr, nv@ie.teicrete.gr
[2]Aalborg University, Medialogy Section, AD:MT, Copenhagen, A.C.Meyers Vænge 15
gt@create.aau.dk

Abstract. Emotion recognition is essential in human communication and social interaction. Children with autism have been reported to exhibit deficits in understanding and expressing emotions. Those deficits seem to be rather permanent so intervention tools for improving those impairments are desirable. Educational interventions for teaching emotion recognition should occur as early as possible. It is argued that Serious Games can be very effective in the areas of therapy and education for children with autism. However, those computer interventions require considerable skills for interaction. Before the age of 6, most children with autism do not have such basic motor skills in order to manipulate a mouse or a keyboard. Our approach takes account of the specific characteristics of preschoolers with autism and their physical inabilities. By creating an educational computer game, which provides physical interaction with natural user interface (NUI), we aim to support early intervention and to enhance emotion recognition skills.

Keywords: autism, facial emotion recognition, gesture-based interaction, Kinect, natural user interface.

1. Introduction

Autism, according to the Diagnostic and Statistical Manual (DSM-IV-TR) of Mental Disorders [1], is a Pervasive Developmental Disorder (PDD) characterized by impairments in social interaction, in communication and by restricted, repetitive and stereotyped patterns of behavior, interests and activities. Children with the same diagnosis of autism may exhibit different symptoms and may demonstrate markedly different behaviors and skills. The spectrum of symptoms can range from mild to severe and efficient diagnosis is difficult. Autism is also described as an Autistic Spectrum Disorder (ASD) due to the variability with which the disorder is manifested. In this article autism and ASD will be referred interchangeably.

Social interaction impairments, a core feature of ASD, involve difficulties in understanding and expressing emotions [2]. Social interaction is the mutual influence between individuals, during which people exchange verbal and nonverbal messages, in order to provide and receive information for themselves and for the others. It is a process of production and exchange of signs that usually affects the behavior of people involved in it. Marked impairments in the use of nonverbal behaviors such as facial

expressions, according to DSM-IV-TR, can be responsible for qualitative impaired social interaction. Nonverbal communication is the expression of emotions, moods, attitudes and the general inner world expressed through the body. It constitutes the largest part of a communication process and facilitates clarification between communicators to define the possible role that each of them has at each moment during this transaction. Source of nonverbal signals is the human body and particularly the face, the eyes, the postures, the body movements and the gestures.

Facial expressions give important clues about emotions and provide a key mechanism for understanding, identifying and conveying them. Facial expressions underline the feelings of emotions. Children with autism often fail to recognize the qualitative differences and associations between various expressions of emotions [3]. Due to limited social and emotional understanding they do not know how to adequate interact with other people which sometimes leads to inappropriate behaviors. Studies have reported that young children with autism experience difficulties recognizing expressions and adults with autism are not as good as typically developing adults at emotion recognition [4]. It has also been recorded that individuals with autism are significantly impaired and exhibit heterogeneity in their emotion processing [5], have difficulties in recognizing emotions from the upper part of the face [6] and exhibit a deficit in overall emotion recognition from facial expressions [7]. Toddlers with autism focus their attention on a single facial feature and treat people as objects [8]. Visual scanning of faces in autism revealed an increased visual fixation time on mouth region and a significant less time on eyes region that was associated with impairment in daily social interaction [9]. There is also evidence that individuals with autism and typically developing individuals decode facial expressions through different mechanisms [10]. A recent study was conducted to evaluate verbal and perceptual skills implicated in the recognition of facial emotions. Individuals with ASD, 5-20 years old, were tested for their perception and identification of facial emotions. Results indicated unimpaired ability to label basic facial emotions and impaired ability to generalize them [11]. Other studies support that individuals with ASDs do not show impaired emotion recognition [12]and these results indicate the wide variation in the manner that individuals are affected.

2. Related Work

Treatment approaches aim to improve social interaction, conquest communication and control inappropriate behavior. Children with autism are more likely to initiate positive interaction after treatment [13]. Education is considered as the main solution for the socio-emotional deficits and training is claimed to improve face processing abilities and strategies in autism [14]. A variety of educational interventions have been proposed for children with autism and many proponents have supported developmental improvement and other benefits [15].

2.1. Traditional Educational Interventions

Traditional therapy techniques and tools for teaching children with autism about emotions are Social Stories™, Developmental Individualized and Relationship based (DIR) / Floortime, Social Communication Emotional Regulation, Transactional Support (SCERTS), Applied Behavioral Analysis (ABA), Early Intensive Behavioral Intervention (EIBI), Picture Exchange Communication System (PECS) and Treatment and Education of Autistic and Related Communication Handicapped CHildren (TEACCH).

Social Stories™, developed by Carol Gray [16] are an approach for teaching individuals with ASD social behaviors. They are short stories that describe and give information about social situations or interaction which children may find difficult or confusing. Their main goal is to provide accurate social information for improving understanding of events that may lead to more effective responses and not for effecting changes. DIR / Floortime parent intervention [17] can help children with autism to connect emotionally and to build social and intellectual skills. This approach follows the child's emotional interests and provides one to one, intensive, play - based intervention. SCERTS is a framework that incorporates practices from other approaches and evidence-based practices [18]. It is a supporting multidisciplinary model for children with autism to enhance socio-emotional and communication abilities. The ABA therapy is often used as a treatment for children with autism. It is a widespread and recognized method for increasing learning, communication and appropriate social behavior [19]. Positive reinforcement, reward for desired behaviors and ignorance for inappropriate behaviors are the main characteristics. According to the ABA intervention method, teaching children with autism about emotions can be achieved by providing examples of appropriate emotional behavior and then rewarding when a child gives the correct emotional response. Young children with ASDs usually receive a home-based program, the EIBI, which is based on the principles and technologies of ABA [20]. Early intervention appears to lessen the effects of autism and children with ASD appear most able to benefit when intervention begins very early (2-4 years old) [21], [22]. Toddlers, who attended an early intervention program, appear to benefit from this, since 31% of those children were functioning in the typical developing range after the intervention [23].

Children with ASD are reported to have strong visual processing capability and a good performance on difficult visual search tasks [24], [25]. Augmentative and Alternative Communication (AAC), such as PECS, is frequently used to increase functional communication in children with ASD. PECS is an effective visually-based system for communication via icons [26]. Visual supports are also suggested for social skill development enhancement in young children with ASD [27]. Picture cards with cartoon faces or illustrations of people faces or photos showing different facial emotional expressions reinforce and support learning. Programs that emphasize visual support strategies are commonly used in education classrooms. A well-known and widely applied model, the TEACCH, is a teaching strategy which emphasizes in structured and predictable learning environment. It utilizes visual cues to increase independence and to teach new skills, such as facial emotions, to children with autism. It involves daily schedules, visual materials, individualized treatment and parental support [28].

2.2. Computer Interventions

Computers are rich, stable, predictable, consistent teaching tools and they provide a proper and more motivational learning environment for individuals with autism [29]. They are great educational tools since children with autism often experience discomfort with unpredictable social environment and they prefer a controlled learning environment [30]. Autistic individuals can enjoy learning and improve their skills with computer-based intervention. Nowadays computers are the most adaptable assistive technology devices available for children with autism and various computer games have been developed to help them to manipulate their impairments. Some of those games focus on their social interaction training and especially learning about emotions [31]. Although effects on social and emotional skills are mixed, computer intervention is a promising practice. In a recent review, Wainer and Ingersoll [30] examined a number of innovation computer programs as educational interventions for people with ASD. They focused on studies describing programs to teach language, emotions or social skills. Their analysis showed that those tools are promising strategies for delivering direct intervention to individuals with ASD.

Currently, ample researches in Serious Games for children with autism have been done. Serious Games are designed for a primary purpose other than pure entertainment, fun or enjoyment [32] and in relations to autism they cover matters related to education, therapy for communication, psychomotor treatment and social behavior enhancement [33]. Serious Games for ASD education are designed to help teachers or student during the teaching and/or learning process. Studies show that Serious Games are very effective in the areas of therapy and education for such children.

The Emotion Trainer [34] is a multimedia computer program for improving school age students' ability to recognize and predict emotions in others. It has positive effects on users' understanding of emotion, particularly with repeated use. Mind Reading [35] is an interactive systematic emotion guide for teaching individuals with Asperger syndrome. Experiments show that Mind Reading is effective in teaching adults with Asperger syndrome or high-functioning autism to recognize complex emotions. Another computer training program for teenagers with autism is the "What to choose" game [36]. It is software with human and cartoon facial expressions, 3D images, text and audio for training individuals with autism in understanding dialogues that contain pragmatic subtleties. Children with autism have failed to take into account the causal link between facial expressions and the outcome of the dialogue. cMotion [37] is a computer game that uses virtual characters to teach emotion recognition and the programming concept to children with autism. The game is designed to teach the users how to recognize facial expressions and manipulate an interactive virtual character by using a visual drag-and-drop programming interface. A computer-based intervention for face training is the Let's Face It! (LFI!) program [38]. This program is comprised of seven interactive computer games that target the specific face impairments associated with autism. Those games are organized into a theoretical hierarchy of face processing domains. The Let's Face It! Program shows promise as an effective intervention tool and treatment alternative. Emotion Mirror is a project that integrates Computer Expression Recognition Toolbox (CERT) with the program Let's Face it! [39]. It is a computer assisted intervention system to enhance facial expression perception and production in children with ASD. This game could be beneficial for children who already have learned labeling and understanding of emotions. The LIFEisGAME is a

facial emotion recognition learning system based on the interaction between humans and 3D avatars [40]. It is a computer-based approach that uses real time facial synthesis of 3D characters in order to teach autistic people to recognize emotions from facial expressions.

Bernardini et al. [41] proposed ECHOES a Serious Game for children with ASD to practice social communication skills. This project presents an intelligent virtual character that acts both as a peer and as a tutor on a number of different learning activities. These activities can be selected manually by a human operator (practitioner, parent or other carer) through a graphical interface. The experimental results showed encouraging tendencies by relating the effectiveness of the children's interaction with the virtual character acting as a social partner to them. Porayska-Pomsta et al. [42] suggest SHARE-IT, an intelligent and authorable environment to assist children with ASD in gaining social interaction skills. Their tool contains an intelligent agent and a play environment that allows teachers and parents to become co-creators and tailor the game according to the needs of the individual children in their care. Although the design and creation of personalized games is crucial for children with ASD, as reported by the authors, limitations in the agent's intelligence (agent inability to deal with inappropriate or unexpected behavior from the user) contradicts the structured, stable and predictable learning environment that is also crucial.

Table 1. Computer and other interventions

Intervention	Refers to	Age	Test/Evaluation	Mouse/Keyboard	2D/3D	Virtual Characters	Images/Photos	Text/Audio/Video
Emotion Trainer [34]	*Autism / Asperger Syndrome*	*school age*	√	√	*2D*	-	√	T
Mind Reading [35]	*Asperger Syndrome / High Functioning Autism*	*from 8 years old*	√	√	*2D*	-	√	T, A, V
What to choose [36]	*High Functioning Autism*	*teenagers*	√	√	*3D*	√	√	T, A
cMotion [37]	*Autism*	-	-	√	*3D*	-	-	-
Let's Face it! [38]	*Autistic Disorder / Asperger Syndrome / PDD-NOS*	*school age*	√	√	*2D*	-	√	-
Emotion Mirror [39]	*ASD*	-	-	√	-	-	√	V
LIFEisGAME [40]	*ASD*	*from 6 years old*	√	√	*3D*	√	-	A
ECHOES [41]	*Autism Spectrum Conditions*	*young children*	√	*other*	*2D/3D*	√	-	T, A
SHARE-IT [42]	*Autism*	-	-	*other*	*3D*	√	-	-
The Transporters [46]	*Autism / Asperger Syndrome*	*4-8 years old*	√	*other*	*3D*	√	-	A, V
Pix Talk [50]	*Autism*	*2-8 years old*	-	*other*	*2D*	-	√	T

2.3. Other Interventions

Nowadays, there is a research and development trend in using motion-based touchless games for children with disabilities. An ongoing EU funded project called M4ALL[1] that aims to develop a "professional" version of these games and a company called Kinems[2]

[1] http://www.m4allproject.eu
[2] http://www.kinems.com

that develops learning games with natural interaction for children with multiple learning disabilities, are examples of this tendency.

Current studies have also gone considerably beyond the simple use of computers. Diverse technology-based interventions have been employed for empowerment and skill acquisition. Recent reviews [43], [44] have shown that there is a growing number of interventions and report a variety of technologies such as multimedia presentations and virtual environments. Other kinds of interventions include interactive DVDs, wearable devices and mobile applications.

MIT Media Lab proposes a wearable device [45] that perceives and reports on social-emotional information in real-time human interaction. The system records and analyzes the facial expressions and the head movements of the person with whom the wearer is interacting. This wearable platform is suggested as an exploratory and monitoring tool to assist individuals with ASD in perceiving communication in a natural environment.

The Transporters [46], a DVD for teaching emotion recognition, is an animation series for children with ASD (preschoolers or with significant learning difficulties). It involves toy vehicles and real life faces of actors that show emotional expressions in social context. The aim of this program was to teach not just some basic emotions but also some more complex ones. Evaluations of this project showed improvements in emotion comprehension and recognition skills [47], [48] but limited efficiency in teaching basic emotion recognition skills to young children with autism with lower range of cognitive ability [49].

PixTalk [50] is a software application for Windows Mobile Smart-phones which can be used as part of ongoing therapy. Teachers and caregivers can access a web site and select from an online library the images to be downloaded on to the Smart-phone. Children also can browse and select images to express their intentions, desires, and emotions using PixTalk.

3. Our Approach

Difficulties in identifying and describing feelings are assumed to be an integral part of autism. Educational interventions can be used as a tool to help individuals with autism to cope with those deficits. As the number of children diagnosed with autism increased [51], [52], new methods for educating this population become necessary. In several studies, computer-based programs have been widely used with success to teach people with ASD to recognize emotions. However, those computer interventions require considerable skills for interaction as the users have to control a mouse or a keyboard. Such abilities are beyond very young children with autism as they have major restriction in their efficiency to interact with computers. Our aim is to design and develop a gesture controlled Serious Game, as an early intervention, for preschoolers (2-6 years old) with autism to teach them basic facial emotions. Our approach takes into account the specific characteristics of preschoolers with autism and their physical abilities. By creating an educational computer game which proposes physical interaction, we hope to make early intervention more appealing and to foster learning of emotions. This software intends to support individuals with autism, their families and their trainers and also to assist the preschool teaching and learning process.

Educating children with ASD and particularly teaching them to recognize and identify emotions from facial expressions is a significant challenge and a complex task. The use of educational software for teaching social and emotional skills could help students with ASD to improve those abilities [53]. Learning tasks developed in digital environments using information technology can motivate the desire to learn in ASD students. As we have already mentioned in the Related Work, computer interventions appear to be particularly appropriate for people with ASD for several reasons. Traditional interventions previously mentioned can be transferred into a computerized version. In our game, we will provide one to one intensive play-based intervention, visual support, positive reinforcement and reward, structural and predictable learning environment and we will incorporate practices from all traditional approaches already mentioned in order to make intervention more efficient.

Many approaches to technology-enhanced intervention rely on educational methods shown to result in good outcomes. Computer interventions such as Serious Games could be a good approach as they also have positive effects on children with autism. Serious Games have the potential to support the process of learning and to motivate individuals to learn more. They usually run on a personal computer and they provide a different style of learning. We will attempt to apply a Serious Game approach to teach children with autism facial emotion recognition.

Previews studies that used Serious Games with children with autism have taken for granted the required skills and in particular the ability to use the mouse or the keyboard. People with ASD demonstrate delay in fine motor skills which causes difficulties in grasping and manipulating objects, such as a mouse [54]. The difficulties they encounter include moving the computer mouse to designated area, corresponding to the location of the cursor to the mouse movement, pressing down and lifting up fingers for the clicking motion, and clicking the correct button on the mouse to make selection [55]. Those difficulties are also found in typically developing individuals. Very young children (autistic and non-autistic) are unable to functionally operate the computer mouse. Experiments showed that four and five year old non-autistic children make more and less accurate mouse sub-movements on approach to targets than young adults [56]. With the increase of age, children in this study demonstrated significantly faster and more accurate use of the mouse which gives evidence of a strong link between speed and accuracy skills and developmental maturity. The same problems occur when players are required to use other game controllers such as joysticks and gamepads. Various research studies have been conducted to evaluate game controllers with the use of ISO 9241-9 [57] based on Fitts' law tasks which is an effective and widely used predictor of performance and comfort. For point and select task, evaluation showed that participants prefer using a mouse and results indicated that remote pointing devices perform poorly in terms of throughput, speed and error rate when compared to a mouse [58]. Touchpads are consider to be a good solution for young children but evaluations have also shown inferior performance, increased movement time, lower throughput and higher error rates when compared with a joystick [59], a trackball [60] and a mouse [61]. Thus, we propose an interaction based on gestures and a controller-free interface as a different interaction technique. Our game will allow user to employ gestures for navigation and interaction.

4. Design and Implementation

In this paper we present an educational computer-based single player game specially designed for Greek preschoolers with autism. The primary objective of this game is to assist young children with ASD to identify different emotions from facial expressions. The main goal of our game is to provide recognition and understanding of facial emotions through early intervention.

As a Serious Game, our development was based on the following principles: (a) it should have an impact on the player in a real life context [62], (b) it is explicitly designed to reach a specific purpose beyond the game itself and (c) it aims to teach preschoolers with autism, facial emotion recognition in order to enhance their social interaction.

Taking into account specific characteristics of autism, we designed the game in order to meet the needs of students with ASD. A recent study conducted to analyze user needs for Serious Games for teaching children with ASD emotions, revealed the characteristics of the children's game play behaviors [63]. The observation showed repetition, matching instead of learning the features, lack of holistic face processing and deliberately incorrect selection. According to those findings, our game was intentionally designed to avoid such behaviors. For repetition, we decided not to give them the opportunity to choose the same emotion again and again. For matching, instead of learning the features, we describe the features of facial expressions in a separate level. For lack of holistic face processing, we describe all the face features that reveal the emotion and ask them to look at each feature separately. For deliberate incorrect selection, nothing special happens when they give a wrong answer.

Our design also incorporates a theory-driven game design framework supported by learning and developmental theories [64]. The framework is based on the integration of Kolb's experiential learning model and Piaget's cognitive model. From this systematic approach were extracted six essential elements for designing games to teach children with ASD emotions. Those elements are: matching, recognition, observation, understanding, generalizing and mimicking. We took those elements into consideration during the design process.

4.1. Game Environment

The game environment is simple and less detailed in order to avoid children's distraction. Individuals with autism are reported to have enhanced perception of details [65] which may causes distraction. For those reasons we select black context presented on a white background and grayscale stimuli. Black and white contrast may also help to increase and retain child's attention and keep them focused on the screen.

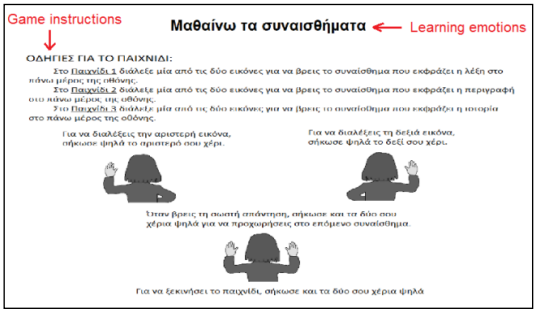

Fig. 1. Example of game instruction page

Game begins with an instruction page where the child is informed what is going to happen, what she/he has to do and how she/he can do it. Apart from the text on the screen, audio instructions are also provided. Audio cues are important as the information presented is clear and age-appropriate. When the child feels ready, she/he can choose to start the game. The game provides a structure learning environment which consists of 3 different levels with increasing difficulty. Breaking the teaching intervention into small learning steps makes the task easier to perform. In the first level children should learn labeling emotions by correlating emotion terms with images. In the second level they should learn to recognize emotions from their description and their association with facial features. In the third level they should learn to identify the causes of various feelings in different situations, obtained through the use of social stories. Those three levels provide recognition, matching, observation, understanding and generalization of facial emotions.

Fig. 2. First level – labeling emotions (incorrect selection) [66]

Individuals with autism are usually visual learners, which mean that they understand written words, photos and visual information better than spoken language. Information is good to be presented through their strongest processing area. When teaching individuals with autism about emotions, it is important to keep explanations as simple and as concrete as possible. It is also recommended to describe each feeling pictorially by using pictures with clear outline, minimal details and color [67]. For young children it is advisable to keep to the basic emotions. In our approach, the basic emotions selected include happy, sad, angry, scared and surprised. Those emotions were chosen because typically developing children can recognize and understand them between 2 and 7 years of age. The face stimuli we used are 15 grayscale photographs of male and female faces, taken from the CAlifornia Facial Expressions (CAFE) dataset [66]. This

dataset was selected as the most appropriate with respect to the emotion recognition task since all images meet FACS criteria [68] and all faces have been certified as "FACS-correct" [69]. The stimuli are presented on each trial with different pairs of photos and the goal is to choose the correct image.

4.2. System Development

Our game is implemented with the use of Microsoft Kinect, which is a motion sensing input device able to track movement and voice, and even identify faces, without the need for any additional devices. Kinect is a low cost and simple way for motion capturing. In more detail, it offers simple, reliable skeleton tracking and a Software Development Kit (SDK). The Microsoft Kinect SDK is used with C# as backend. Among the advantages using C# is that we can integrate XNA Game Studio to develop our game, as well as to utilize the XNA libraries (provided by Microsoft) for graphics creation.

4.3. Interaction with the System

Interaction may be one of the areas that need to be developed with extreme care, depending on the activities and skills to be worked on each of the games and target group. The computer-based interventions that use a keyboard or a mouse for interaction might cause problem with the younger children which may not be able to use a computer. Our gesture-based interaction approach moves the control of computer from a mouse and keyboard, to the motions of the body via new input devices.

Our game is designed to use non-touch based NUI and to be controlled by hand gestures. The gestures are translated into control commands. The player has three possible actions in all game states, to choose left or right image and move to the next play area. These basic actions are implemented with efficient and easy to use gestures. Moving to the next play area requires a two-hand gesture which is performed by moving both hands above the head. Selecting the left image requires a one-hand gesture which is performed by moving the left hand above head. Respectively, selecting the right image requires a one-hand gesture which is performed by moving the right hand above head.

During the game, if the player selects the correct or incorrect stimuli, the system will inform player that he/she gave the correct or incorrect answer. Each answer provides an audio and a visual feedback such as operation-related sounds and changing the images' color. A voice telling "Bravo" rewards player for the correct answer and a voice telling "Try again" encourages the player to try again when the user provides an incorrect answer. There are no other sound effects because individuals with ASD may suffer from auditory sensitivity [70], may demonstrate oversensitivity to certain sounds, even at low volume and may feel discomfort when exposed to certain sounds [71]. Visual feedback is also provided by changing the image's color into light green for the correct answer and into light red for incorrect answer. Light colors were selected because in ASD occur a reduced chromatic discrimination that is due to general reduction in sensitivity [72]. Children with autism are less accurate at detecting the differences between colors and

have less accurate color perception [73]. Individuals with ASD also experience hypersensitivity which includes increased light sensitivity and harshness of colors. Acute sensitivity to color is presented by their preference or avoidance of a particular color [74].

5. Research Focus, Methodology and Findings

The rationale for the present work summarizes in the cumulative effect that the above-mentioned practices have on teaching children with ASD. In this context, new teaching techniques and interaction methods have been exploited primarily as gaming tool for improved child - learning relationship.

5.1. Context

Our game exhibits several novel characteristics, which differentiate it from other forms of educational computer games and platforms. It introduces novel interaction techniques which allow the "player" to focus on the learning process without distraction from the use of "complex" interaction devices that need skills. Consequently, its primary focus is to enable preschoolers, with the use of NUI devices to perform learning tasks and provide an effective and engaging learning experience. To achieve this, we build on technologies such as, game engines and advanced human-computer interaction. To illustrate some of the concepts described so far and to provide insight into the features of our game, we present an indicative scenario emphasizing on structured and NUI based game execution for educating preschoolers with ASD. Our game begins with an instruction page where the child is informed on what is going to happen, what it has to be done and how it is done. A two-hand gesture which is performed by moving both hands above the head is required to start the game. In the first level, children should learn labeling emotions by correlating emotion terms with images. The stimuli are presented on each trial with different pair of photos and the goal is to choose the correct image among the two. Selecting the left image requires a one-hand gesture which is performed by moving the left hand above the head. Image's color changes into light red for incorrect answer. Selecting the right image requires a one-hand gesture which is performed by moving the right hand above the head. Image's color changes into light green for the correct answer. Moving to the next play area requires a two-hand gesture which is performed by moving both hands above the head. In the second level they should learn to recognize emotions from their description and their association with facial features. In the third level they should learn to identify the causes of various feelings in different situations, obtained through the use of social stories. At the end of the game, there is a congratulation message.

5.2. Research question and methods

Having outlined relevant general issues, we will attempt to briefly elaborate on some key research questions. These can be broadly grouped into three constituents, namely:

- NUI devises related questions such as what are the advantages of NUI devices when preschoolers are involved; which is the impact of them to the player involved, and how they are enhancing the learning process.
- Emotional state questions as to how player's emotional state is affecting its learning abilities and how such games help to overcome these obstacles.
- Play area settings related questions aiming to unfold player's cooperation matters in conjunction with surroundings while in learning process with the use of such games.

To address the above questions, research methods were used to collect data and envision new capabilities for improved learning processes. Specifically, an experimental descriptive survey was conducted during game execution sessions, which included, videos and text notes in order to provide the insights required.

As our intention was to unfold hidden or implicit elements of educational games with the use of NUI devices for preschoolers with ASD diagnosis, game sessions were tailored so as to feed envisioning of new (improved) learning practices. The focus of the findings is put on player's emotional state, usage of NUI devices and play area settings.

5.3. Findings

Our survey was directed to preschoolers with ASD and was complemented by documented materials. The findings can be analyzed into emotional state versus game performance, emotional state versus surroundings, concentration and game performance, and NUI device and game acknowledgement.

Figure 3 summarize data collected during the learning sessions performed. Specifically, the survey identified 5 areas of importance namely the emotional state, the surroundings, the pre session start game acknowledgement, the instructor pre session start recognition and game interaction during playing. Areas 1, 2, and 5 were expected to be identified. Areas 3 and 4 were unexpected and strengthened our assumptions for NUI devices.

		22/05/2013	06/06/2013	07/06/2013	10/06/2013	11/06/2013	12/06/2013	14/06/2013	17/06/2013	18/06/2013	19/06/2013	20/06/2013	26/06/2013
emotional stage	**mood**	tired	happy	happy	happy	indifferent	happy	happy	unhappy	happy	happy	happy	very happy
	spirit	no cooperation	neutral	positive	positive	neutral	positive	positive	negative	positive	positive	positive	very positive
	activity	restless	calm	calm	calm	calm	calm	calm	calm	calm	calm	calm	calm
	cooperation	negative	neutral	positive	positive	neutral	positive	positive	neutral	positive	positive	positive	very positive
	attention	very limited	limited	positive	positive	distracted	distracted	positive	distracted	distracted	distracted	very positive	positive
surroundings paramaters	**play spot settings**	N/A	same	same	same	same	same	same	minor changes	minor changes	same	same	same
	room settings	N/A	same	same	same	minor changes	minor changes	same	major changes	minor changes	major changes	same	same
	outdoor settings	N/A	same	same	same	same	minor changes	same	same	major changes	minor changes	same	same
Game Recognition Pre-Play Time	**Kinect avatar acknowledgement**	No	Yes	demanding	demanding	indifferent	demanding	demanding	indifferent	Yes	demanding	demanding	demanding
	game acceptance	No	Yes	Yes	demanding	indifferent	Yes	demanding	Yes	Yes	Yes	Yes	demanding
	Game acknowledgement	No	No	Yes	demanding	indifferent	Yes	demanding	Yes	Yes	Yes	Yes	demanding
Instructor	**Instructor acknowledgement**	No	No	No	No	Yes	Yes	excellent	excellent	excellent	excellent	excellent	excellent
Game	**Game Play** *(1st Repetion Game Level1)*	N/A	limited effort	good	good	no effort	good	good	no effort	average	average	good	good
	Game Play *(1st Repetion Game Level1)*	N/A	no effort	good	average	no effort	good	good	no effort	average	no effort	good	no effort
	Game Play *(1st Repetion Game Level1)*	N/A	no effort	good	no effort	no effort	good	good	no effort	average	no effort	good	no effort
	One Hand commands *(1st Repetion)*	N/A	average	good	good	good	good	excellent	no effort	limited effort	limited effort	excellent	bad
	Two Hands *(1st Repetion)*	N/A	good	excellent	excellent	no effort	excellent	excellent	average	good	average	excellent	excellent

Fig. 3. Raw experimental data

Figure 4 refers to our first group of research questions namely: (a) what are the advantages of NUI devices when preschoolers are involved, (b) which is the impact of them to the player involved and (c) how they are enhancing the learning process. As shown, regardless of the emotional state of the participant (happy, unhappy etc.) and regardless of minor changes of the surroundings, participant were acknowledging the use of NUI devices and especially the device avatar which was demanded even before the session start. Thus we can safely deduct that the use of NUI devices enhance game acceptance, game recognition and player involvement & participation, i.e. the learning process.

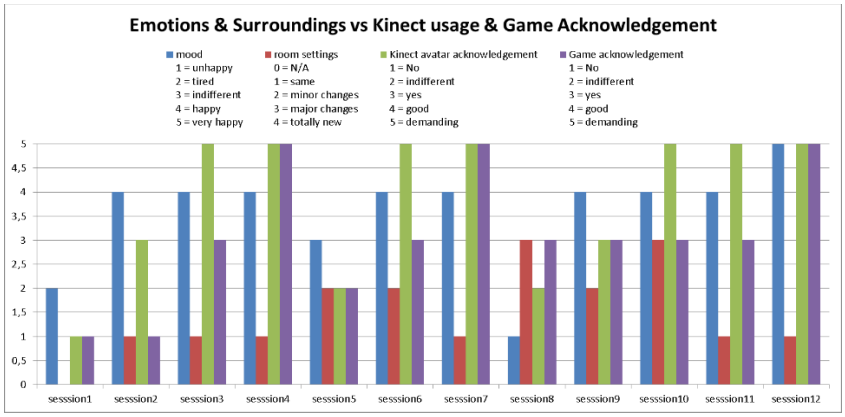

Fig. 4. NUI devices and Game Acknowledgement

Figure 5 refers to the second group of research questions i.e. (a) how player's emotional state is affecting its learning abilities and (b) how such games help to overcome these obstacles. We can see that player's emotional state is affecting its learning abilities in such a way that sometimes it makes the learning process impossible. Even so we can see that game was accepted and an effort was made by the player, not always with success.

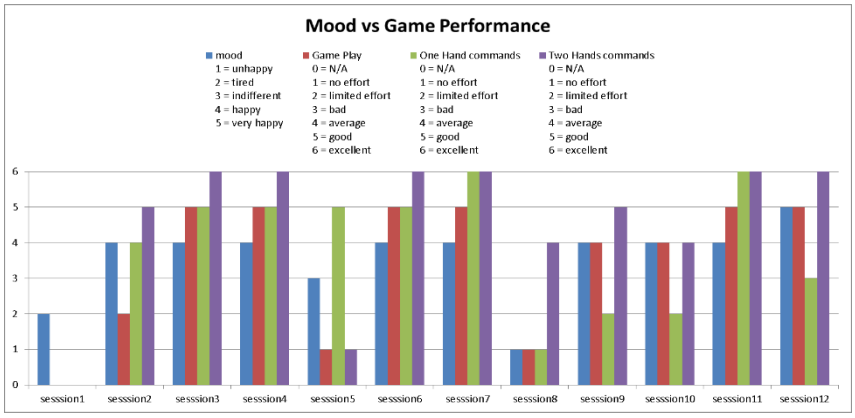

Fig. 5. Emotional state versus Game performance

Figure 6 refers to the third group of research questions, i.e. Play area settings related questions aiming to unfold player's cooperation matters in conjunction with surroundings while in learning process with the use of such games. As shown even minor changes in the surroundings (play spot, room, outdoor etc.) affect dramatically the game acknowledgement, game acceptance, and game interaction but have a small or no effect on the NUI device avatar acknowledgement. Thus we can also here safely deduct that the use of NUI devices enhance the game acceptance i.e. the learning process.

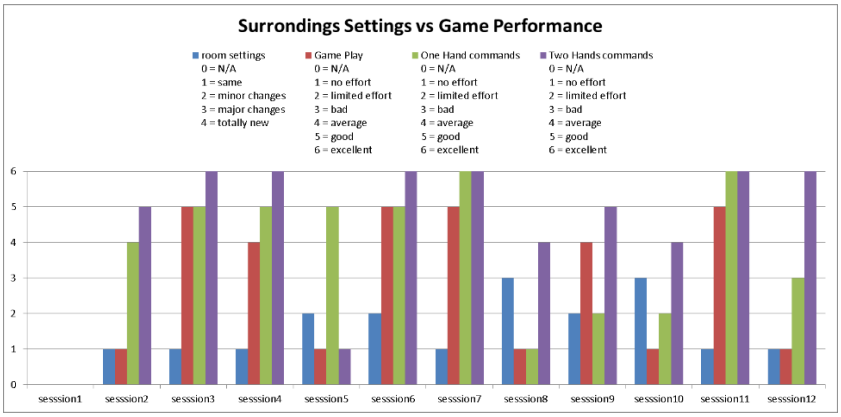

Fig. 6. Play Area surroundings versus Game performance

Summarizing our findings analysis we are lead to the following conclusions: (a) NUI devices enhance the game acceptance i.e. the learning process, (b) Player's emotional state is affecting its learning abilities and NUI devices can help to overcome, up to a degree these obstacles, and (c) Play area settings affect the player's attention which in turn affects the learning process. The use of NUI devices and especially recognizable avatars help to minimize the phenomenon.

6. Discussion and Future Work

Increased interest in the potential of technology for users with autism is motivated by the rapidly growing needs for providing intervention. Research shows that early intervention can greatly improve the lives of children with autism. Computer-based tools have been widely used with success to teach individuals with autism. However, early intervention cannot be achieved with computers due to lack of skills. Gesture-based interaction aims to contribute to overcoming this restriction [75].

NUI devices have been used in learning environments successfully [76]. Therefore, Serious games with NUI interaction could be a promising intervention strategy because they are appealing, motivating for young children to use and convenient to access. When control is achieved through natural gestures, the user does not have to learn how to perform actions or how to operate games. Gesture-based interventions in order to help children with autism to improve their skills must be carefully designed in accordance with their abilities and needs.

Kinect offers an unlimited number of opportunities for new applications such as gesture-based interventions for individuals with autism. As Kinect can support gesture and speech recognition and offer motion-sensing and interaction, children with autism can benefit to improve a broader range of skills.

Our experimental results are twofold, (a) technology interventions provide a positive reaction to alternative interaction techniques (i.e. NUI I/O) to individuals with ASD and (b) technology acceptance is highly connected with individual's emotional state and game surroundings settings.

Future work could include further involvement of multimodal NUI devices so that the roles, between player and machine, are reversed and the player performs gestures, sounds, grimaces etc. and the machine responds. Such a design, of Serious Games that will enable children to perform and the system to respond will support a "learn by doing" methodology. Furthermore, special gestures could be designed to improve interaction between children and machine

References

1. American Psychiatric Association, "Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition – Text Revision (DSM-IV-TR)," 2000.
2. S. W. White, K. Keonig and L. Scahill, "Social Skills Development in Children with Autism Spectrum Disorders: A review of the Intervention Research," Journal of autism and developmental disorders, vol. 37, no. 10, pp. 1858-1868, 2007.
3. P. R. Hobson, "The autistic child's appraisal of expressions of emotion," Journal of Child Psychology and Psychiatry, vol. 27, no. 3, pp. 321-342, 1986.
4. K. M. Rump, et al., "The Development of Emotion Recognition in Individuals With Autism," Child development, vol. 80, no. 5, pp. 1434-1447, 2009.
5. M. D. Lerner, J. C. McPartland and J. P. Morris, "Multimodal emotion processing in autism spectrum disorders: An event-related potential study," Developmental cognitive neuroscience, vol. 3, pp. 11-21, 2013.
6. S. Kuusikko, et al., "Emotion recognition in children and adolescents with autism spectrum disorders," Journal of autism and developmental disorders, vol. 39, no. 6, pp. 938-945, 2009.
7. M. Uljarevic and A. Hamilton, "Recognition of emotions in autism: a formal meta-analysis," Journal of autism and developmental disorders, vol. 43, no. 7, pp. 1517-1526, 2013.
8. K. A. Pelphrey, N. J. Sasson and J. S. Rezni, "Visual scanning of faces in autism," Journal of autism and developmental disorders, vol. 32, no. 4, pp. 249-261, 2002.
9. W. Jones, K. Carr and A. Klin, "Absence of preferential looking to the eyes of approaching adults predicts level of social disability in 2-year-old toddlers with autism spectrum disorder," Arch Gen Psychiatry, vol. 65, no. 8, pp. 946-954, 2008.
10. M. B. Harms, A. Martin and G. L. Wallace, "Facial emotion recognition in autism spectrum disorders: a review of behavioral and neuroimaging studies," Neuropsychology review, vol. 20, no. 3, pp. 290-322, 2010.
11. J. W. Tanaka, et al., "The perception and identification of facial emotions in individuals with autism spectrum disorders using the Let's Face It! Emotion Skills Battery," Journal of Child Psychology and Psychiatry, vol. 53, no. 12, pp. 1259-1267, 2012.

12. J. L. Tracy, et al., "Is emotion recognition impaired in individuals with autism spectrum disorders?," Journal of autism and developmental disorders, vol. 41, no. 1, pp. 102-109, 2011.
13. N. Bauminger, "The facilitation of social-emotional understanding and social interaction in high-functioning children with autism: Intervention outcomes.," Journal of autism and developmental disorders, vol. 32, no. 4, pp. 283-298, 2002.
14. S. Faja, et al., "Becoming a face expert: a computerized face-training program for high-functioning individuals with autism spectrum disorders," Developmental neuropsychology, vol. 33, no. 1, pp. 1-24, 2007.
15. S. Eikeseth, "Outcome of comprehensive psycho-educational interventions for young children with autism," Research in developmental disabilities, vol. 30, no. 1, pp. 158-178, 2009.
16. C. A. Gray and J. D. Garand, "Social stories: Improving responses of students with autism with accurate social information," Focus on Autism and Other Developmental Disabilities, vol. 8, no. 1, pp. 1-10, 1993.
17. K. Pajareya and K. Nopmaneejumruslers, "A One-Year Prospective Follow-Up Study of a DIR/Floortime™ Parent Training Intervention for Preschool Children with Autistic Spectrum Disorders," Journal of the Medical Association of Thailand, vol. 95, no. 9, pp. 1184-1193, 2012.
18. B. M. Prizant, et al., "The SCERTS Model: A transactional, family-centered approach to enhancing communication and socioemotional abilities of children with autism spectrum disorder," Infants & Young Children, vol. 16, no. 4, pp. 296-316, 2003.
19. S. Axelrod, K. K. McElrath and B. Wine, "Applied behavior analysis: autism and beyond," Behavioral Interventions, vol. 27, no. 1, pp. 1-15, 2012.
20. B. Reichow, "Overview of meta-analyses on early intensive behavioral intervention for young children with autism spectrum disorders," Journal of autism and developmental disorders, vol. 42, no. 4, pp. 512-520, 2012.
21. P. Tzanakaki, et al., "How and why do parents choose Early Intensive Behavioral Intervention for their young child with Autism?," Education and training in autism and developmental disabilities, vol. 47, no. 1, pp. 58-71, 2012.
22. N. Peters-Scheffer, et al., "A meta-analytic study on the effectiveness of comprehensive ABA-based early intervention programs for children with Autism Spectrum Disorders," Research in Autism Spectrum Disorders, vol. 5, no. 1, pp. 60-69, 2011.
23. A. C. Stahmer, N. Akshoomoff and A. B. Cunningham, "Inclusion for toddlers with autism spectrum disorders The first ten years of a community program," autism, vol. 15, no. 5, pp. 625-641, 2011.
24. Z. Kaldy, et al., "Toddlers with autism spectrum disorder are more successful at visual search than typically developing toddlers," Developmental science, vol. 14, no. 5, pp. 980-988, 2011.
25. C. Gonzalez , et al., "Practice makes improvement: How adults with autism out-perform others in a naturalistic visual search task," Journal of autism and developmental disorders, vol. 43, no. 10, pp. 2259-2268, 2013.
26. J. B. Ganz, R. L. Simpson and E. M. Lund, "The picture exchange communication system (PECS): A promising method for improving communication skills of learners with autism spectrum disorders," Education and Training in Autism and Developmental Disabilities , vol. 47, no. 2, pp. 176-186, 2012.
27. A. K. Moody,, "Family Connections: Visual Supports for Promoting Social Skills in Young Children: A Family Perspective," Childhood Education, vol. 88, no. 3, pp. 191-194, 2012.

28. G. B. Mesibov, V. Shea and E. Schopler, The TEACCH approach to autism spectrum disorders, New York, NY, US: Springer Science + Business Media, 2005.
29. T. R. Goldsmith and L. A. LeBlanc, "Use of technology in interventions for children with autism," Journal of Early and Intensive Behavior Intervention, vol.1, no.2, pp.166-178, 2004.
30. A. L. Wainer and B. R. Ingersoll, "The use of innovative computer technology for teaching social communication to individuals with autism spectrum disorders," Research in Autism Spectrum Disorders, vol. 5, no. 1, pp. 96-107, 2011.
31. B. O. Ploog, et al., "Use of Computer-Assisted Technologies (CAT) to Enhance Social, Communicative, and Language Development in Children with Autism Spectrum Disorders," Journal of Autism and Developmental Disorders, pp. 1-22, 2012.
32. D. Djaouti, et al., "Origins of Serious Games," Serious Games and Edutainment Applications, pp. 25-43, 2011.
33. M. Noor, F. Shahbodin and C. Pee, "Serious Game for Autism Children: Review of Literature," World Academy of Science, Engineering and Technology, vol.64, no.124, pp 647-652.
34. M. Silver and P. Oakes, "Evaluation of a new computer intervention to teach people with autism or Asperger syndrome to recognize and predict emotions in others," Autism, vol. 5, no. 3, pp. 299-316, 2001.
35. O. Golan and S. Baron-Cohen, "Systemizing empathy: Teaching adults with Asperger syndrome or high-functioning autism to recognize complex emotions using interactive multimedia," Development and Psychopathology, vol. 18, no. 2, pp. 591-617, 2006.
36. O. Grynszpan, J. C. Martin and J. Nadel, "Multimedia interfaces for users with high functioning autism: An empirical investigation," International Journal of Human-Computer Studies, vol. 66, no. 8, pp. 628-639, 2008.
37. S. L. Finkelstein, et al., "cMotion: A new game design to teach emotion recognition and programming logic to children using virtual humans," IEEE Virtual Reality Conference, pp. 249-250, 2009.
38. J. W. Tanaka, et al., "Using computerized games to teach face recognition skills to children with autism spectrum disorder: The Let's Face It! program," Journal of Child Psychology and Psychiatry, vol. 51, no. 8, pp. 944-952, 2010.
39. D. Deriso, et al., "Emotion Mirror: A Novel Intervention for Autism Based on Real-Time Expression Recognition," vol. 7585, pp. 671-674, 2012.
40. J. C. Miranda, et al., "Interactive Technology: Teaching People with Autism to Recognize Facial Emotions," Autism Spectrum Disorders - From Genes to Environment, 2011.
41. S. Bernardini, et al., "ECHOES: An intelligent serious game for fostering social communication in children with autism," Information Sciences, in press 2013.
42. K. Porayska-Pomsta, et al., "Building an Intelligent, Authorable Serious Game for Autistic Children and Their Carers," Advances in Computer Entertainment, Springer International Publishing, pp. 456-475, 2013.
43. S. Ramdoss, et al., "Use of computer-based interventions to teach communication skills to children with autism spectrum disorders: A systematic review," Journal of Behavioral Education, vol.20, no.1, pp.55-76, 2011.
44. S. Parsons and S. Cobb, "State-of-the-art of virtual reality technologies for children on the autism spectrum," European Journal of Special Needs Education, vol. 26, no. 3, pp. 355-366, 2011.
45. R. el Kaliouby, A. Teeters and R. W. Picard, "An exploratory social-emotional

prosthetic for autism spectrum disorders," International Workshop on Wearable and Implantable Body Sensor Networks, pp. 2-4, 2006.

46. S. Baron-Cohen, et al., "Transported to a world of emotion," The Psychologist, vol. 20, no. 2, pp. 76-77, 2007.
47. S. Baron-Cohen, O. Golan and E. Ashwin, "Can emotion recognition be taught to children with autism spectrum conditions?," Philosophical Transactions of the Royal Society B-Biological Sciences, vol. 364, no. 1535, pp. 3567-3574, 2009.
48. O. Golan, et al., "Enhancing emotion recognition in children with autism spectrum conditions: an intervention using animated vehicles with real emotional faces," Journal of Autism and Developmental Disorders, vol. 40, no. 3, pp. 269-279, 2010.
49. B. T. Williams, K. M. Gray and B. J. Tonge, "Teaching emotion recognition skills to young children with autism: a randomised controlled trial of an emotion training programme," Journal of Child Psychology and Psychiatry, vol. 53, no. 12, pp. 1268-1276, 2012.
50. G. De Leo, et al., "A smart-phone application and a companion website for the improvement of the communication skills of children with autism: clinical rationale, technical development and preliminary results," Journal of Medical Systems, vol. 35, no. 4, pp. 703-711, 2011.
51. J. Baio, "Prevalence of autism spectrum disorders--Autism and Developmental Disabilities Monitoring Network, 14 sites, United States, 2008," MMWR Surveillance Summaries, vol. 61, no. 3, pp. 1-19, 30 March 2012.
52. M. Elsabbagh et al., "Global Prevalence of Autism and Other Pervasive Developmental Disorders," Autism Research, vol. 5, no. 3, pp. 160-179, 11 April 2012.
53. J. Lozano-Martínez, et al., "Software for Teaching Emotions to Students with Autism Spectrum Disorder," Revista Comunicar, vol. 18, no. 36, pp. 139-148, 2011.
54. E. Jasmin, et al., "Sensori-motor and daily living skills of preschool children with autism spectrum disorders," Journal of Autism and Developmental Disorders, vol.39, no.2, pp.231-241, 2009.
55. K. Sitdhisanguan, et al., "Using tangible user interfaces in computer-based training systems for low-functioning autistic children," Personal and Ubiquitous Computing, vol. 16, no. 2, pp. 143-155, 2012.
56. A. E. Lane and J. M. Ziviani, "Factors influencing skilled use of the computer mouse by school-aged children," Computers & Education, vol. 55, no. 3, pp. 1112-1122, 2010.
57. ISO, ISO 9241-9 Ergonomic requirements for office work with visual display terminals (VDTs) - Part 9: Requirements for non-keyboard input devices, International Organization for Standardization, 2000.
58. D. Natapov, S. J. Castellucci and I. S. MacKenzie, "ISO 9241-9 evaluation of video game controllers," Proceedings of Graphics Interface 2009, pp. 223-230, May 2009.
59. S. A. Douglas, A. E. Kirkpatrick and I. S. MacKenzie, "Testing pointing device performance and user assessment with the ISO 9241, Part 9 standard," Proceedings of the SIGCHI conference on Human Factors in Computing Systems, pp. 215-222, May 1999.
60. I. S. MacKenzie, T. Kauppinen and M. Silfverberg, "Accuracy measures for evaluating computer pointing devices," Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 9-16, 2001.
61. M. Akamatsu and, I. S. MacKenzie, "Changes in applied force to a touchpad during pointing tasks," International Journal of Industrial Ergonomics, vol. 29, no. 3, pp. 171-182, 2002.

62. K. Mitgutsch and N. Alvarado, "Purposeful by design?: a serious game design assessment framework," Proceedings of the International Conference on the Foundations of Digital Games, pp. 121-128, 2012.
63. B. Abirached, Y. Zhang and J. H. Park, "Understanding User Needs for Serious Games for Teaching Children with Autism Spectrum Disorders Emotions," Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications, pp. 1054-1063, 2012.
64. J. H. Park, B. Abirached and Y. Zhang, "A framework for designing assistive technologies for teaching children with ASDs emotions," Extended Abstracts on Human Factors in Computing Systems, pp. 2423-2428, 2012.
65. E. Ashwin, et al., "Eagle-eyed visual acuity: an experimental investigation of enhanced perception in autism," Biological Psychiatry, vol. 65, no. 1, pp. 17-21, 2009.
66. M. N. Dailey, G. W. Cottrell and J. Reilly, "CAlifornia Facial Expressions (CAFE)," 2001. [Online]. Available: http://www.cs.ucsd.edu/users/gary/CAFE/.
67. S. Dodd, Understanding Autism, Sydney: Elsevier, 2004.
68. P. Ekman and W. V. Friesen, Facial Action Coding System, Palo Alto: Consulting Psychologist Press, 1978.
69. M. L. Smith, et al., "Transmitting and Decoding Facial Expressions," Psychological Science, vol. 16, no. 3, pp. 184-189, 2005.
70. E. Gomes, F. S. Pedroso and M. B. Wagner, "Auditory hypersensitivity in the autistic spectrum disorder (original title: Hipersensibilidade auditiva no transtorno do espectro autístico)," Pró-Fono Revista de Atualização Científica, vol. 20, no. 4, pp. 279-284, 2008.
71. Y. H. Tan, et al., "Auditory abnormalities in children with autism," Open Journal of Psychiatry, vol. 2, no. 1, pp. 33-37, 2012.
72. A. Franklin, et al., "Reduced chromatic discrimination in children with autism spectrum disorders," Developmental Science, vol. 13, no. 1, pp. 188-200, 2010.
73. A. Franklin, et al., "Color perception in children with autism," Journal of Autism and Developmental Disorders, vol. 38, no. 10, pp. 1837-1847, 2008.
74. R. A. Coulter, "Understanding the Visual Symptoms of Individuals with Autism Spectrum Disorder (ASD)," Optometry & Vision Development, vol. 40, no. 3, pp. 164-175, 2009.
75. E. Christinaki, N. Vidakis and G. Triantafyllidis, "Facial expression recognition teaching to preschoolers with autism: a natural user interface approach," Proceedings of the 6th Balkan Conference in Informatics. ACM, pp. 141-148, 2013.
76. N. Maldonado, "Technology in the Classroom: Wii: An Innovative Learning Tool in the Classroom." Childhood Education, vol, 86, no 4, pp. 284-285, 2010.

Eirini Christinaki was born in Crete, Greece. She received her BSc degree in Applied Informatics and Multimedia from the Technological Educational Institute of Crete in 2013. She is currently a postgraduate student in Informatics and Multimedia at the same Institute. In March 2013, she joined the Computational Medicine Laboratory (CML) of Institute of Computer Science at Foundation for Research and Technology - Hellas (FORTH). Since November 2013, she participates in research project SEMEOTICONS: SEMEiotic Oriented Technology for Individual's CardiOmetabolic risk self-assessmeNt and Self-monitoring. Her current research interests are mainly in the areas of Serious Games, Affective Computing, Biomedical Engineering and Health Informatics.

Nikolas Vidakis was born in Crete, Greece. He received a BSc(Hons) in Computing in Business from the University of Northumbria at Newcastle in 1993. Dr Vidakis obtained his Ph.D degree from the Technical University of Vienna in 1997. In the past, he has worked for the Technical University of Vienna (Austria), Minoan Lines S.A. (Greece) and the Technological Education Institution of Crete (Greece). During his work at Minoan Lines and the Technological Education Institution of Crete he has been involved in a few Research and Technological Development projects, funded by national and European organizations. Since October 2005, Dr Vidakis is an Assistant Professor at the Department of Informatics Engineering, Faculty of Applied Technologies at the Technological Education Institution of Crete and since 2006 a member of the search laboratory iSTLab. His current research interests are in the areas of HCI, SE, Serious Games, VCoP. More information about publication, research interests, as well as a full CV can be found at the following address (http://www.istl.teiher.gr)

Georgios A. Triantafyllidis was born in Thessaloniki, Greece, in 1975. He received the Diploma Degree in electrical engineering and the Ph.D. degree in image/video processing from Aristotle University of Thessaloniki, Greece, in 1997 and 2002, respectively. From 1997 till 2000 he worked as a research assistant at the Information Processing Lab of the Aristotle University of Thessaloniki. From 2000 to 2008 he joined the Informatics and Telematics Institute of CERTH in Thessaloniki as an associate and since 2003 as a senior researcher. From 2005 to 2008 he was also with the Electrical and Computer Eng Dept of the Aristotle University of Thessaloniki as a visiting lecturer. Then, he joined the Applied Informatics and Multimedia Dept of the Technological Educational Institute of Crete, Greece, as an assistant professor. Since August 2012, he has been appointed assistant professor in the Department of Medialogy at Aalborg University Copenhagen (Denmark). Dr Triantafyllidis has been involved in 16 national and international research competitive projects, where he conducted research in various fields of image/video processing/analysis, intelligent systems and 2D/3D computer vision. He was member of the 3DTV Network of Excellence and the general chair of the 3DTV CON 2007 and CGIM 2012 conferences. He is an editorial board member in 3D Research Journal of Springer Publishing. He edited three special issues on 3DTV and published more than 65 referred research papers with more than 300 citations.

Received: February 15, 2014; Accepted: May 28, 2014