Anuario de Psicología Clínica y de la Salud
Annuary of Clinical and Health Psychology
Year 2012 • Volume 08 • Pages 39 to 44

Departamento de Personalidad, Evaluación y Tratamiento Psicológicos

Monographic Article

Pictogram Room: Natural Interaction Technologies to Aid in the Development of Children with Autism

Gerardo Herrera, Xavier Casas, Javier Sevilla, Luis Rosa, Carlos Pardo, Javier Plaza
Universidad de Valencia
Rita Jordan
University of Birmingham
Sylvain Le Groux
Universidad Pompeu Fabra

Abstract

The pictogram room is a set of educational video games for children and adults with autistic spectrum disorder (ASD). Aspects like music and structured learning have been taken into account in the game designs, because many studies have indicated that such aspects improve the learning results among people with ASD.

To define the educational goals of the project, specific difficulties in key development areas have been considered: corporal language, attention and imitation.

There is already extensive knowledge on how to provide effective support to people with ASD through visual structure and music. Based on this knowledge, we have created a pedagogical proposal aimed at overcoming their difficulties while making use of their personal strong points and taking advantage of new technologies as well.

Keywords: Autism, corporal language, technology, augmented reality, games

Received:21/11/2012 Accepted:18/12/2012

Introduction and Thesis

Numerous studies have shown that vision is the sense that is best preserved in autistic spectrum disorder (ASD) and that even concepts that do not usually evoke visual images can activate the areas that are supposedly reserved for the visual processing of the parietal and occipital cortex among people suffering from this disorder (Kana et al., 2006, Gaffrey et al, 2007). In relation to these findings, different studies have shown that most people with ASD are visual as opposed to verbal thinkers (Grandin, 1995; Jordan and Riding, 1995) and the most common intervention programs in ASD—including the TEACCH (Mesibov and Howley 2010) and the PECS (Frost and Bondy, 2002)—mainly use learning that is mediated visually, although such learning can be adapted to other sensory modes or used in conjunction with them.

On the other hand, several studies have noted that music is an excellent supplement for visual supports and an effective tool for fostering joint attention (Reitman, 2005) and education (Standley, 1996), encouraging communicative behaviors (Edgerton, 1994), and developing language, cognitive concepts, motor abilities and behavior in early intervention programs (Standley and Hughes 1996). Other studies have noted that music helps increase word recognition, icon identification, sketched concepts and pre-verbal abilities in early intervention (Register, 2001) and music as a facilitator and as reinforcement for increasing the verbal response among children with limited verbal communication (Braithwaite and Sigafoos, 1998). Finally, still other studies have evidenced that music helps to organize and structure information (Claussen and Thaut, 1997) and to foster interactions and social relations (Ulfarsdottir and Erwin, 1999).

Contact informaction:
Javier Sevilla
Javier.Sevilla@uv.es
Instituto de Robótica C/Catedrático José Beltrán 2
46980 – Paterna (Valencia)
(+34) 963543573

Information and communication technologies (ICTs) are increasingly used in the educational intervention of ASDs as they provide multimedia and virtual reality tools to help people develop social abilities (Golan and Baron-Cohen, 2006; Parsons, Mitchell and Leonard, 2005), fictional games (Herrera et al., 2008) and communication (Miller et al., 2006), to cite just a few examples. In an exploration of the reports by parents, professors, therapists and researchers, Hart (2005) noted that children with autism had a high affinity for computers.

Although it is possible to work with other sensory modes, the main component of most of the devices and applications that involve computer-assisted learning is the visual and the auditory channel. If we consider the studies cited above regarding visual supports and regarding music, it appears evident that technologies which combine both factors could provide an excellent opportunity for providing effective supports.

Augmented reality is a field of investigation of ICT that combines the information we perceive from the real world with information generated by the computer in real time. Its name makes reference to the fact that this technology combines real information with graphics. In a prior study (Herrera, Jordan and Gimeno, 2006), we analyzed the advantages and drawbacks of this technology among people with ASD both with and without intellectual disability.

Technologies evolve very quickly and since that study, efforts have also been aimed at developing technologies known as "natural interaction." With these technologies, people use their own bodies and natural gestures to interact with the computer, without the need to use any device (keyboard, mouse, joystick, remote control, etc.) to handle the digital information and thus interact with the device. The main developments with this technology have used open source codes, allowing them to be spread rapidly while giving the research community easy access and allowing IT applications to be developed. (http://www.openni.org/). To provide support for this technology, different devices have been launched over the past few months; when connected to a computer or a video console, these allow the user to interact naturally with the IT applications and videogames (Microsoft Kinect, Asus Xtion Pro, etc).

Project Description

Origin

The daily experiences of professionals who work in educational intervention for autism have shown that most people with autism can learn to use pictograms in a variety of situations. These involve communicating with cards used to request something (as in the PECS system cited earlier), and the use of schedules, hours and other types of visual supports (developed for use in the system, for example, in the TEACCH program referred to above).

However, the fact that people use the pictograms and are able to associate them with certain situations, tasks or their own communicative intent does not mean that they actually understand what is being graphically displayed on the pictograms. The experience of numerous professionals who work with people with autism on a daily basis indicates that when the pictogram suffers even a minor modification, recognition often ceases. Small variations in the background color, modifications in the outline of the drawings or variations in the sizes of different parts of the drawing can create an obstacle that keeps people with autism from recognizing the pictogram.

This leads us to believe that in those cases, people with autism may simply be memorizing a certain group of colors, shapes and sizes without distinguishing what is actually being shown. In the figure above, for example, a person with autism may not recognize that the person in the figure is holding a glass of water which in turn is represented by another visual element. In addition, the person with autism may not understand that both elements are associated and incorporated to an action or gesture.

Given this difficulty, in one of the studies cited previously (Herrera, Jordan and Gimeno, 2006), an initial prototype was developed. The prototype involved a screen that displayed the image of the person looking at the screen and his or her surroundings in real time. The computer then superimposed other images on this real image, using a position indicated by a system of infrared marks. This created an important restriction, since the user had to don each of these elements in order for the system to acknowledge the position of each part of her body at all times.

As can be observed in the figure, images generated by the computer (like the person's body outline, the water drinking pictogram and the cup pictogram) are superimposed on the real image of the person. This way, the person with ASD is represented in the water drinking pictogram and can access this representation in a way that is totally visual.

This demonstrator, which was not utilized with people with autism but only to test the viability of certain pedagogical theories, was the first step of a research trend that soon evolved into the Pictogram Room project. Led by the Autism and Learning Disabilities Group at the Universidad de Valencia, the project also involved researchers from the University of Birmingham and the Universidad Pompeu Fabra. Two associations that work with people with autism and their families in Spain, Autismo Burgos and Autism Ávila, collaborated

Figure 1. Example of the 'drinking' pictogram (Source: Arasaac)

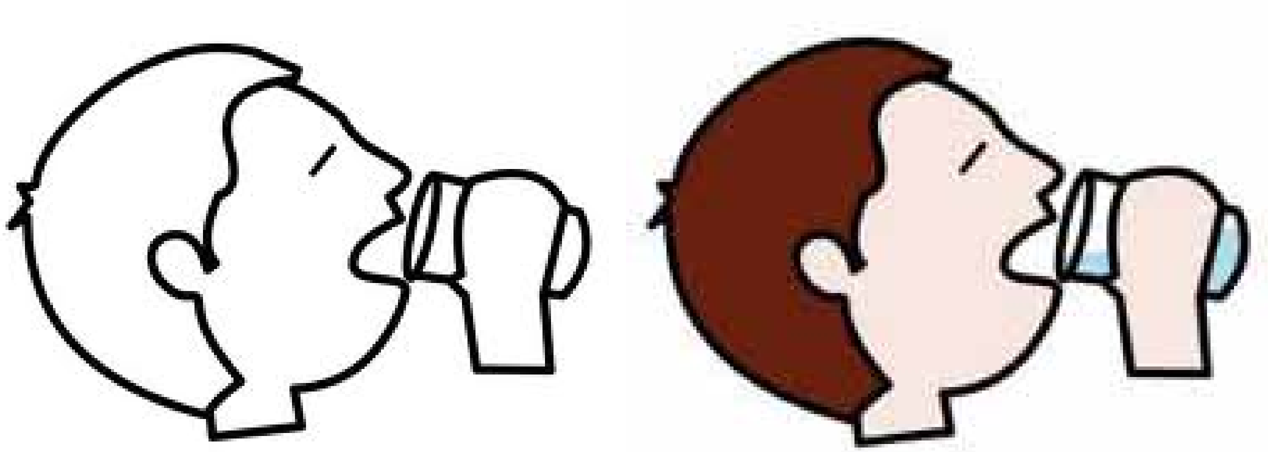
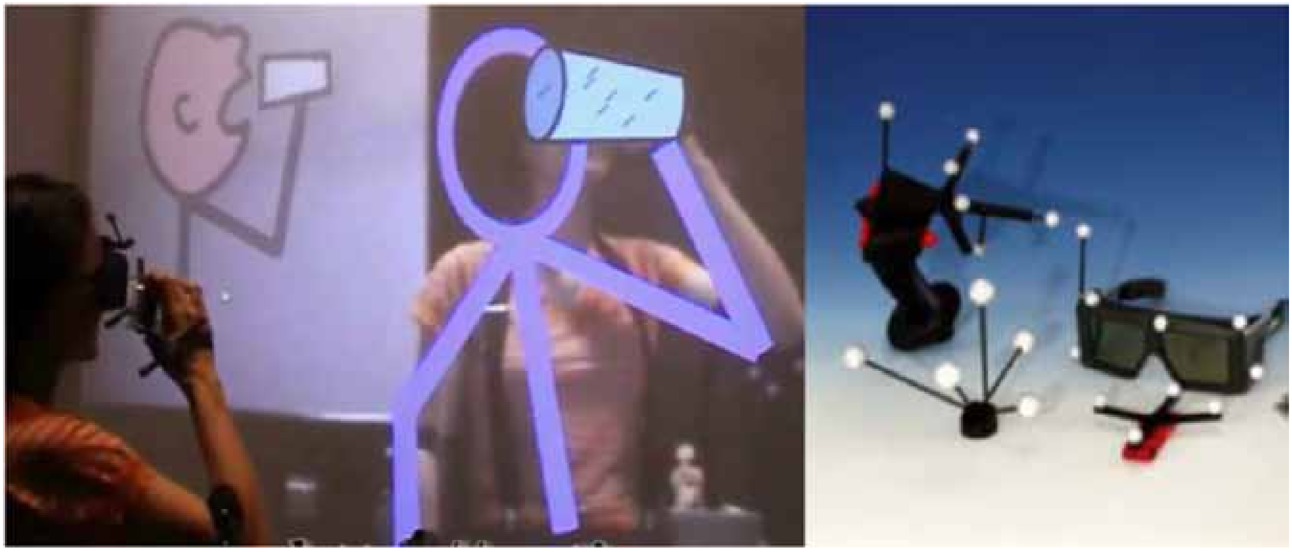


Figure 2. Images of the augmented reality prototype.



in the validation of the pedagogic designs of the project. This initiative is funded by the Orange Foundation and by from the Avanza Ciudadanía Program (the Spanish Ministry of Industry, Trade and Tourism).

Pedagogic Design

The main goal of the Pictogram Room Project was to achieve a pedagogic design that could potentially create an approach to the difficulties of people with autism whose developmental abilities are most affected by the disorder.

In this regard, visual supports, music and playability criteria were selected in order to foster the motivation of the user and a predisposition towards learning. Thus intervention aspects such as self-recognition, joint attention, communication and relationships with others were all addressed.

Self-recognition and the development of body awareness

One of the main goals is self-recognition (Rosa et al., 2010) and the development of body awareness. People with autism and intellectual disability often display an evident lack of self-awareness (Ferrari and Wendy, 1983). One of the most commonly used experimental procedures to determine self-awareness among toddlers with normal child development has been the use of a procedure of self-recognition in the mirror or the "rouge test" (Amsterdam, 1972; Bertenhal and Fisher, 1978; Lewis and Brooks, 1978). In this procedure, the child's nose is dotted with a bit of make-up and the child is then placed in front of the mirror. If the child begins to touch his own nose as opposed to the mirror, she is considered to have recognized herself. When Ferrari and Matthews (1983) applied this paradigm, they found that nearly half of the people with autism who participated in their study did not display clear self-recognition. In addition, the authors established a strong link between the lack of self-recognition among people with autism and their mental age. In other words, people with autism who did not display self-recognition before the mirror were those with a mental age lower than the development level at which children developing normally recognize themselves in the mirror. Therefore, the level of cognitive development achieved by the child appears to be critical to developing the ability of recognizing oneself. Different studies of evolution concur that the age at which average children present clear self-recognition before the mirror is approximately 18-24 months (Bertenthal and Fischer, 1978; Lewis and Brooks, 1979); however, there were no cases of self-recognition earlier than the age of 15 months. According to Michael Lewis, all children achieve visual recognition by the age of 24 months except for children with autism and/or with other alterations in development that keep them from reaching the minimal mental age of 15-18 months.

Thus, based on the affordances described above regarding the use of AR, the Pictogram Room would target people with autism and intellectual disability who do not display clear visual recognition of themselves in the mirror and who have a mental age of around 15-18 months. However, the main criterion would be the inability or difficulty to recognize oneself and not the mental age, since as we know the sequence of acquiring abilities is not always the same for people with autism as it is for people with normal development.

Another aspect to approach is the ability to differentiate oneself from others, an ability that is often very difficult for people with autism (Ferrari and Wendy, 1983; Goldfarb, 1967 yand1970; Hobson and colleagues, 2006; Mahler, 1952; Russell and Jarrold, 1999). To respond to this, the sketch of the body outline is overlaid onto the image of the person looking in the mirror during the educational games of the Pictogram Room. Thus, the movements of the body outline sketch correspond to those of the user. This way, the user with autism receives a visual, schematic representation of her body at all times, a figure that moves and responds according to the user's own movements and actions. The overlay of the body sketch is also used for interactions with other people in order to help the person with autism differentiate himself from others through different stimuli of the body sketch of each person (i.e. color, size, texture). In addition, AR allows us to increase the salience of the cause-effect reactions that are produced in the environment through visual variations such as light intensity, coloring, shading, different textures, etc.

Educational games available in Pictogram Room

The first version of the Pictogram Room project was published in March 2012 and it can be accessed at http://www.pictogramas.org. The website provides a total of forty educational games focused on two dimensions of developments: body awareness and postures. Subsequent versions will continue with this pedagogical proposal, incorporating other educational games related to joint attention, imitation and communication.

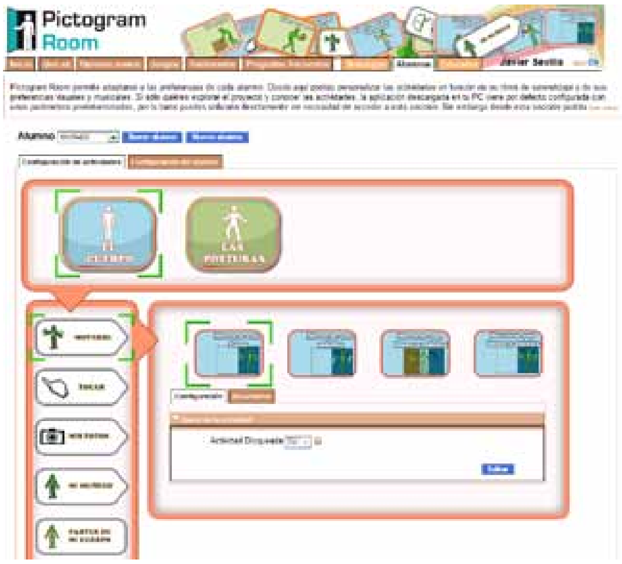
Different games have been grouped around different work dimensions associated with a child's development. Let's take, for example, 'The Body.' This series has several sets of activities that have been designed to favor the development of body awareness. With this set of games in front of the mirror, the aim is for the participant to gradually pay more attention to the different parts of her body and the figure who represents her. In all of the games, the educator has to help the participant in addition to also playing his role within the game.

The website has five subgroups for users to work on different concepts such as 'Moving', which fosters an understanding of the cause-effect relations related to body movement. In 'Touching', the user has to pay attention to his hands in order to make progress in the games. The user takes a series of instant photos of herself in 'My Pictures' and then will have to pick out her own photos when they are compared with those of other people. In 'My Figure', the participant meets the pictogram who will represent him on screen; the last subgroup is 'Parts of My Body' which we will describe in more detail below.

Each subgroup has four activities that address different concepts and gradually increase in difficulty (so that each series has a total of twenty educational games). This is the case of the last subgroup, 'The Body', which has four games.

In the first game, 'Parts of My Body', the participant has to move different parts of her body quickly in order to progress in the game. The second game is similar but this time, the participant can choose to work with a blank background similar to the one used on poster boards with pictograms. On this poster board, a gray figure appears and as the different parts of the figure's body are colored in, the user must move those body parts to advance in the game. In the third exercise, the user

Figure 3. Screen capture of the project's website displaying the educational games 'The Body'.



is represented by a gray pictogram and she has to color in the pictogram by using different parts of her body to touch paint cubes that appear on screen. Each paint cube is specific to a different part of the body. Working either alone or with the educator, the person with autism is thus provided with a fun way of learning body awareness. Finally, the 'Coloring Rain' series has the classic game 'Space Invaders' in which pictograms rain down and a part of the body lights up. The participant has to choose the ones that are missing in order to fill in the colors of his body.

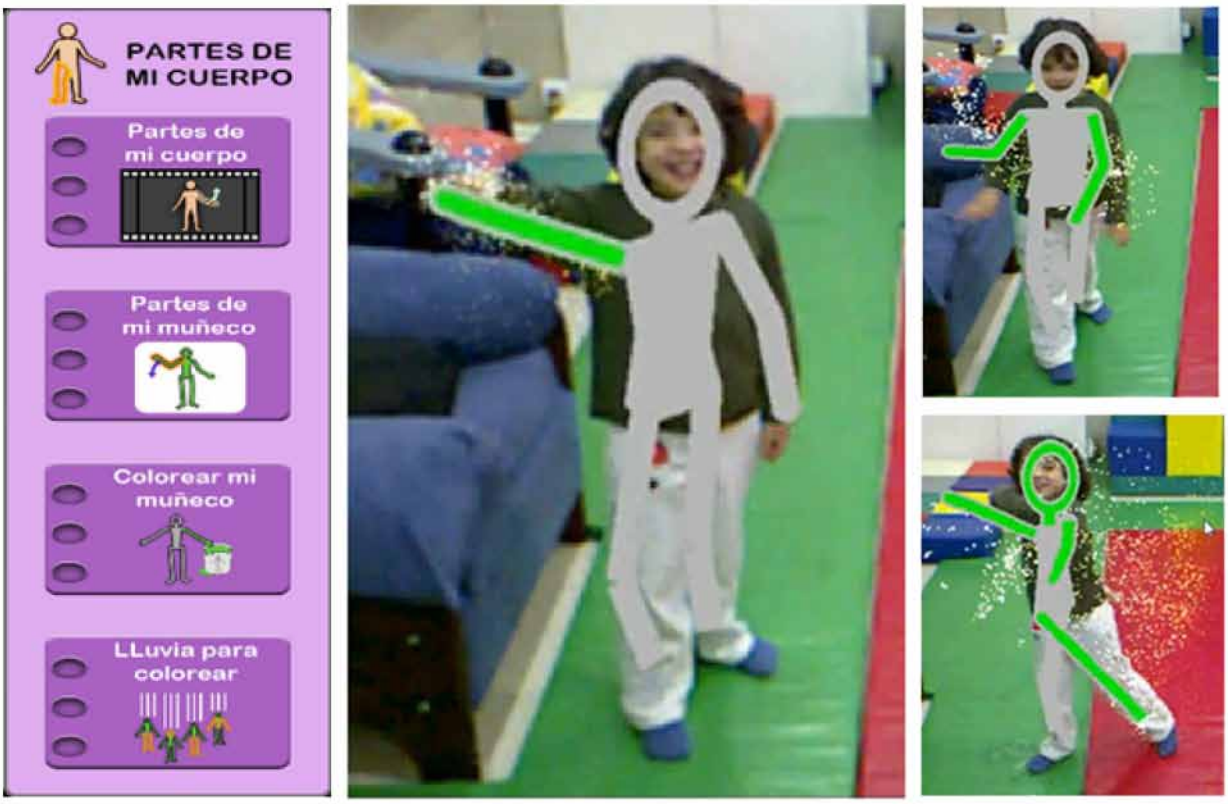
On the project website, each project user can generate several students and configure the different elements that appear in the game for each student, including videos, images and sounds. In addition, the user can track the progress of the student and unblock the activities she sees fit. This configuration is updated automatically each time the application is initialized.

Conclusion

This text presents some of the ways in which virtual reality can improve the care of people diagnosed with autistic spectrum disorders. The combination of new technologies and therapeutic intervention opens new treatment options that could be highly promising.

However, empirical research is needed to determine the relevance (efficacy, efficiency and effectiveness) of programs such as the one described here. Therefore, the next logical step will involve gathering more information on the results of such programs.

Figure 4: The 'Parts of My Figure' game with a video backdrop in real time



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