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MEDIATE: STRATEGIES FOR INTERACTIVE COMMUNICATION IN A MULTISENSORY ENVIROMENT FOR CHILDREN WITH PROFOUND AUTISM.

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SUMMARY

The Experimentation on Interactive Communication research team (eIC) of the IUA has participated in the conception, approach and development of the project **MEDIATE** (A Multisensory Environment Design for an Interface between Autistic and Typical Expressiveness) 2001/2004, funded by the European Commission within the IST of the V Framework Program.

In this paper we present the work developed during the design and scripting of user interaction with visual stimuli, as well as the strategies followed to establish methodologies that would allow us to overcome the impossibility of typifying the users of this project.

KEYWORDS

Interaction design, Interactive communication, Perception theory, Interface design, Real time image generation, Psychology.

ARTICLE

Definition of the MEDIATE Project

As set forth in the basic design of the project, MEDIATE (A Multisensory Environment Design for an Interface between Autistic and Typical Expressiveness) proposes the creation of a multisensory and interactive environment for boys and girls with profound autism who are unable to engage in verbal communication. (1) By means of visual, auditory and tactile interaction, the project attempts to provide the children with an opportunity to express and enjoy themselves by having them use their bodies as well as certain physical parts of the area that are sensitive to the touch. The prime goal of MEDIATE is to allow the children to play, explore and be creative within a predictable, controllable and safe environment. (2)

The research group in Experimentation with Interactive Communication of the Institute for Audiovisual Studies of Pompeu Fabra University, as a member of the consortium, participated in the definition and conception of the project. As a team specializing in interactive communication, it has taken on the design and development of interaction with visual stimuli, of the system for obtaining data on the users by means of visually recording them, of creating an Intranet for the various participants in the project, and for the production of personalized recordings (DVDs) of the sessions.

Precedents: In an Art Gallery

The first ideas for the project began to take shape by observing autistic children while they experimented with interactive works of art. (3) The children's enthusiasm, their active attitude, the interest they showed and the fact that they appeared to understand the work suggested the ideas that would become the seeds of MEDIATE. These initial observations and conversations allowed us to establish the three basic lines that would structure the project: first, as opposed to what usually occurs in other projects that deal with autism or other handicaps, the approach taken was neither medical nor therapeutic in nature, although the project might produce observations of interest for the families and/or psychologists. Second, we aimed at creating an interactive project that would employ non intrusive technologies, i.e. technologies that would not require the children to use any objects or devices to communicate with the system nor to have any prior knowledge of any code. The children had to be able to reach, move around, interact and leave the environment or interactive area freely. Finally, we aimed at offering an environment that presented a series of simultaneous options for each visual, auditory or tactile mode so that there would be various experiences depending on the child's dialogue.

Team and overall strategies

The MEDIATE team consisted of a consortium from four universities: the School of Art, Design and Media of the University of Portsmouth, who coordinated the project; the Institute of Psychiatry of King's College of the University of London; the Faculteit Kunst, Media & Technologie of the Hogeschool voor Kunsten of Utrecht; and, the research group in Experimentation on Interactive Communication of the University

Institute for Audiovisual Studies of Pompeu Fabra University, Barcelona. The association Autisme Europa and the firm Show Connections also were a part of the project. One of the most innovative features of MEDIATE was the presence in a research project on social communication of three universities specializing in communication, new media and art. This interdisciplinary structure has allowed us to consider hypotheses and establish work guidelines that are not commonly found in research on autism that is tied exclusively to psychology, pedagogy or pharmacology.

Four overall strategies were established in order to achieve the goals of the project:

- Increase and encourage non repetitive attitudes.
- Offer control in order to achieve a sense of agenthood.
- Adapt to each child.
- Incorporate as consultants to the project autistic individuals whose functional level was high.

Psychological Background

The fundamental goal of the project is to have the autistic children who participate in MEDIATE enjoy themselves in order to encourage their creativity and ability to explore, so that they would avoid stereotypical and repetitive attitudes. (4) We also aim to have the children experience the sense of agenthood, i.e., the sense of being in control in an interactive situation. In addition, we wanted the children's parents and teachers to observe the children's experiences in this new context.

Amongst the possible states in which a child might find himself or herself as a response to the stimuli provided by MEDIATE –enjoying himself, showing repetitive attitudes, showing creativity, doing nothing or being bored, we set as a goal that the system should attempt to maintain an active attitude on the part of the child, so that at all times there would be a certain degree of dialogue between the child and the system. One of the parameters that would be adopted to determine the suitability of a stimulus or response of the system to a user action would be to try to establish the capacity that that action would have to sustain the child's activity while attempting to avoid both passivity and overexcitement. While the child is active, the idea is to consolidate dialogue; while the child is passive, the goal is to bring about action. When the child starts to demonstrate repetitive behaviors, the aim is to bring about a non repetitive behavior.

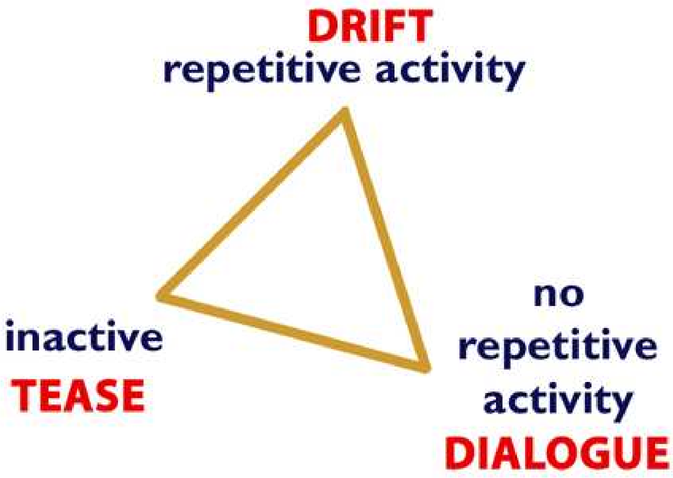


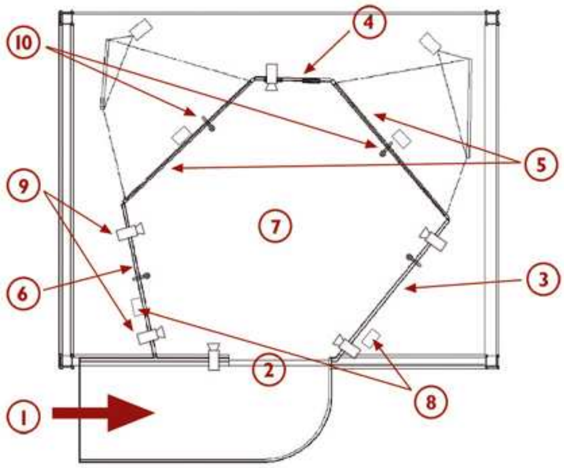
Figure 1: Representation of the attitudes that a user (lower case blue letters) might demonstrate and the responses proposed by the system (upper case red letters).

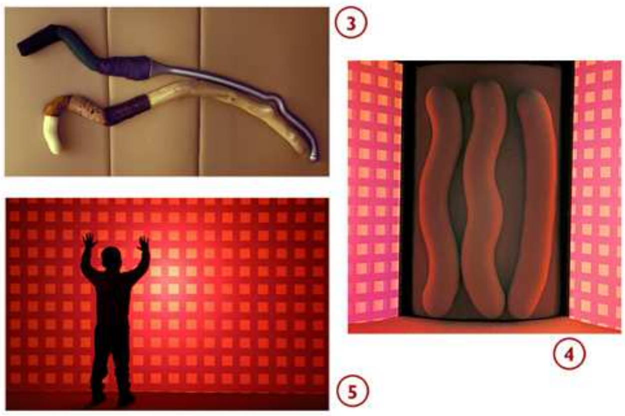
The desire to maintain a certain level of dialogue with the user and at the same time personalize the response to the user's actions by getting away from automatic reactions led us to choose a system of variable interactive responses, as opposed to a system of reactive responses. For example, each part of the system that can provide a response to a user action, such as a floor tile to a step or the projection screen to the touch of a hand, might provide different responses to the child depending on the type of dialogue that occurs at that moment. The observation of the dialogue between the interactive system and the user led us to devote a significant part of the project to creating a system that would allow us to assess the user's states in order to establish the degree of the response. This system was called the *decision-making module*.

Defining the environment of interaction

One of the most interesting points stemming from observing autistic children as they interact with works of art at the beginning of the project was the idea of an environment that allowed interaction with the whole body. This made us consider movement in the space, gesticulation, touch, and oral expressions. We decided that the project would include the design of a space as an interactive environment, and that this space would be large enough to allow movement and circulation of children. At the same time, the space had to be small enough to give an impression of being manageable. [See Figure 2 and Figure 3].

The decision to turn the project interface into a physical space implied rejecting the use of other commonly used strategies that are standard in the design of interactive products: projects employing flat screens, kiosks or presentations involving screens and equipment for writing. These systems were rejected because low functional level autistic children would not be able to use keyboards and mouses due to a lack of motricity and concentration; moreover, these systems do not encourage movement or circulation on the part of the user. We also decided to create objects to encourage tactile interaction with the system. They needed to be incorporated into the structure of the environment, so that the children could experiment with shapes and textures by touch. The creation of independent interactive elements within the space was rejected, however, because they might encourage obsession with the object itself and thus favor isolation of the user.





Figures 2 and 3: Design of the space and photographs of the interactive areas. 1: Access ramp. 2: Entrance. 3: Tune fork tactile and auditory wall. 4: Vibrating interactive wall. 5 & 6: Projection screens. 7: Observation wall. 8: Interactive floor. 9: Microphones and speakers scattered throughout the area. 10: Cameras capturing the images.

Considerations of using a multimode dialogue

Some psychological and pedagogical approaches to working with autistic children concentrate on certain skills and senses. These projects are based on music and singing, on pictures and diagrams, and on dance and drawing, and are very useful in specialized schools and centers. (5) MEDIATE is defined as an observation project, as an area in which children can enjoy the expressive potential of combining sound, touch, vibration, and image, as opposed to being defined in terms of guidelines or methodologies.

Use of several modes allows not only responses between modes or from more than a single mode at a given moment, but also allows users to choose the mode of interaction they want to use. Each child begins the interactive dialogue with the system using the mode that is most attractive to him or her, and can change or incorporate other modes at any time. The system attempts to encourage multimode interaction as a tool to prevent the children from engaging in repetition and stereotypical actions.

We anticipated user responses to actions. We took all types of modes into account and allowed a specific action to obtain a response from another mode; for example, for a noise or scream to cause changes in the shapes or colors projected on the screen. Each action by the user could bring about a direct response within the same mode, in a different mode, or in a combination of several modes simultaneously [Figure 4].

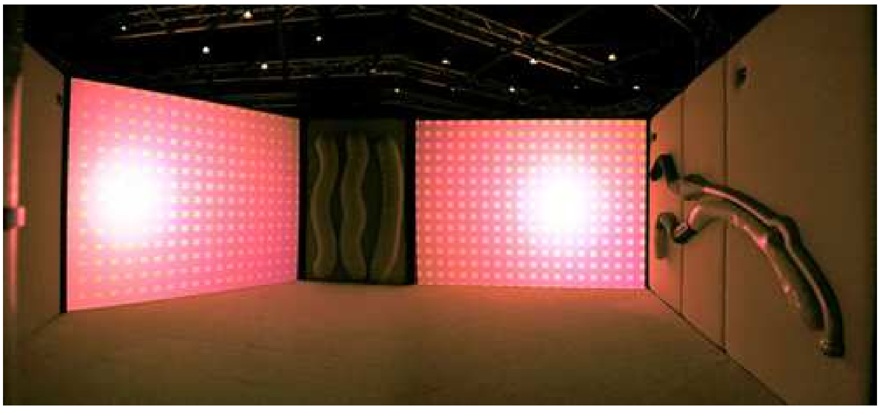


Figure 4. Panoramic view of the interior environment for MEDIATE

Designing the visual interface in a proposal using space

A proposal using space was chosen because it was easy to adapt to interaction with the body. The simplest movement through space, such as entering and taking a few steps, would put the system to work to provide responses to stimulate the child by interactive play. In addition to moving around in the area, other behaviors such as gesticulating, touching, jumping, bending, pressing, screaming or making sounds were noted and used to establish an interactive dialogue. To make this interaction visual, we have incorporated a system of sensors based on infrared light and cameras that capture each action together with a computerized system capable of generating a visual response. All the visual interaction takes place through two walls consisting of floor-to-ceiling screens measuring 3 m x 2.25 m on which the visual stimuli generated by the interactive situations are projected. These two walls are clearly separated for two basic reasons:

1. ***Spatial-temporal continuity***. If the two screens were located next to each other, in a polygonal environment with obvious corners like that of MEDIATE the edges of the two screens would create a boundary or line of demarcation. The psychologists considered the difficulty that low functional level autistic children would have in understanding the visual continuity of a single image shown on two screens or an object moving across two screens. In the end they decided to use the screens independently and faced one opposite the other in order to avoid identification with the cinematographic referent of a single wall as a projection surface.

2. ***Promoting movement of users within the area***. Since the project has opted to use space, the visual interface is designed to promote movement of users throughout the space. The facing projections help to encourage the children to move about and discover the other forms of interaction involving vibration, sound, and touch.

Users cannot be stereotyped

When designing an interactive application, one of the first steps is to analyze and define the target user. (6) Autism, however, does not correspond to a single typology and has a wide range of characteristics of many sorts: it relates to social interaction and dysfunctions in verbal and nonverbal communication as well as in imagination. (7) Consequently, there are many different profiles of profoundly autistic children with no ability to communicate verbally. The uniqueness of each specific case and the presence in some cases or alterations or dysfunctions associated with autism such as phobia towards certain noises or colors or exceptional aptitude for music or drawing together result in an even wider range of possible profiles.

This situation led us to accept the limitation of not being able to characterize the typical user of MEDIATE. We therefore had to establish new strategies and adapt the procedures commonly used in the design of interactive systems. This was the main challenge facing us, and one of the primary research interests of our group.

Interaction design and visual content

The methodologies and design manuals for interaction propose beginning the design of an interactive product by defining and delimiting the content, which will in turn define the type of application and user, the data and processes that are required, and finally the model for interaction and the interface. A different approach was necessary, however, because it was impossible to define the typical user of MEDIATE. As a result, our design needed to be interaction-driven as opposed to content-driven. (8) We thus began by identifying the input and output interfaces and then went on to define a model for the interaction. Finally, we decided upon the type of application and visual elements we could use. In other words, we began by concentrating on the way the user would interact with the application and by analyzing the interface and the types of participation and use it would have. Since we had decided to consider interaction with the entire body, we chose those actions that any child could do as a clear, precise reaction to the system. These actions were simple enough that any child, autistic or not, could perform them:

- Move sideways in relation to the screen
- Move towards or away from the screen
- Gesture in front of the screen
- Touch or lean on the screen
- Remain still.

These actions allowed us to initially propose simple games that could be visual responses to user actions, such as:

- Images appearing or disappearing
- Images increasing or decreasing in size or number
- Images imitating the user’s actions
- Images contrary to the user’s actions.

With these simple interactions, users could understand that they were in control of the situation and that would reinforce their sense of agenthood. With the definition of the actions and possible responses in mind, we began to consider the type of sensors that needed to be used, the degree of definition required and the adjustments and ranges they would have to have.

We were able to achieve an initial stable response with these simple interactions. We were thus in a position to prepare more complex models of visual interaction.

What contents? Which images?

Can an excess of light be prejudicial to an autistic child? Is it better to work with dark or poorly lit spaces? Can they understand the meaning of the images? Or, to the contrary, do they understand them like colors and graphics? Can we communicate better with a system of realistic three-dimensional images such as photographs and videos or is it better to use a two-dimensional, abstract code with colors and shapes? The visual abilities of autistic people, like their auditory and tactile abilities, cannot be generalized to each member of the group: several different situations may obtain, ranging from (cognitive and physical) handicaps to cases with special abilities. This lack of a defined situation led us to consider the visual contents from the simplest levels of structuring visual messages. We started from the morphological elements in the image and accepted that they might be unable to comprehend more complex syntactic structures such as the shape of a figure, visual continuity or the principle of Pragnanz. (9) Our analysis of the visual proposals that the interactive system can generate takes into account the following:

- Morphological aspects of images: darkness, light, color, brightness, movement, shape

- The possibility that these elements might form figures and objects according to the basic principles of Gestalt theory: closing of shapes, proximity, similarity, contrast, continuity.

- The possibility that these figures define a relationship between the shape, the outline of the shape and the background.

- The possibility of understanding an object, group of objects and the integration of objects in other, more complex ones.

- These visual representations can obtain in either a two-dimensional or three-dimensional model.

- These images, figures, and objects can attempt to be more or less symbolic.

When faced with the inability to establish what level of comprehension our users might have – iconographic, iconological or symbolic in Panofsky's terminology, (10) we decided to create a visual space in which figures were generated and which emphasized the figures' ability to structure the relationship between figure and background. In the MEDIATE space the background is dynamic and supplies characteristics such as color, texture and rhythm. The figures are sometimes a part of the background; they may be separated or together with others, or related to other figures to form more complex sets.

These organizations allows us to set up a visual system that permits different levels of reading and interpretation that can evolve and be changed according to the profile of each user. A specific interpretation or reading of the cultural meaning of the images is not necessary. This strategy suits the recognized lack of assimilation of cultural and social conventions among persons with autism.

The other important feature that the consortium aimed for was the sense of control and agenthood that would be gained through the user's interaction with the system. We wanted to exclude the possibility of creating an environment based or defined on the content presented or represented by using representational metaphors. On the visual level, this premise implied eliminating the option, for example, of creating a representation of a dog (or a virtual dog) in the visual space. This representation, in the case of a child with a negative experience with dogs or in that of a child who loves dogs, might lead to a predisposition that would adversely affect the perception of interactive dialog proposed by the system. We therefore decided to work with abstract images or non figure-based representations.

A system of shapes and backgrounds, a particle system

In our research on visual interface design we were faced with a large number of autistic children who had difficulty in integrating the parts of an object into the whole object; this is known as "weak central coherence." (11) For example, when autistic children have a toy car, they may play with it by making the wheel turn with their fingers, but they may not understand how wheels work either on the toy or in general, nor that the set of elements form a car. Another characteristic of weak central coherence occurs in autistic people who have a remarkable ability to find a simple figure such as a triangle or square hidden amongst other figures or lines, a task that a person who is not autistic might take some time to do.

As a result of all these characteristics, we decided to work with separate elements from simple geometry that could be understood as a set and as independent elements or could lose their individual nature to be understood as part of the background. The use of a large set of simple geometric shapes with related behaviors can be considered use of a particle system. (12)

In a particle system each particle can have its own behavior. It may also be the case that the entire set of particles behaves as a group as a result of the sum of individual behaviors. In fact, this is the sort of mechanism involved with flocks of birds or schools of fish. These particles may also be considered individual elements or may be grouped together to form more complex objects. They may also be scattered across the entire screen to blend into and thus form a part of the background.

The graphics that finally became a part of the interactive models allows users with varying degrees of comprehension of messages and visual stimuli to interact and establish a somewhat complex dialogue between their actions and their visual responses. They can perceive a sense of agenthood because they control the flow of communication.

How decisions are made: interaction models

Interaction models were designed to overcome the limitations of reactive systems, in which each action simply unchains the same mechanical response, and to establish a dialogue with users that would contemplate both their state as well as their evolution. Generally speaking, interaction models are a structure in which the strategies that will be used in each specific interactive proposal are defined. In this way, the design of each one of the modalities –sound, tactile, or visual, is no longer only the design of the palette of resources of that mode, the relationship between inputs and outputs that the system can generate on the bases of user actions, but rather becomes a structured proposal comprising several resources, norms of operation and guidelines for variation. The interaction model considers the several states in which interaction occurs: the initial situation, whatever intermediate states that may occur and the final situations. We have represented it by using finite automata [see Figure 5], general structures describing the operation of processes.

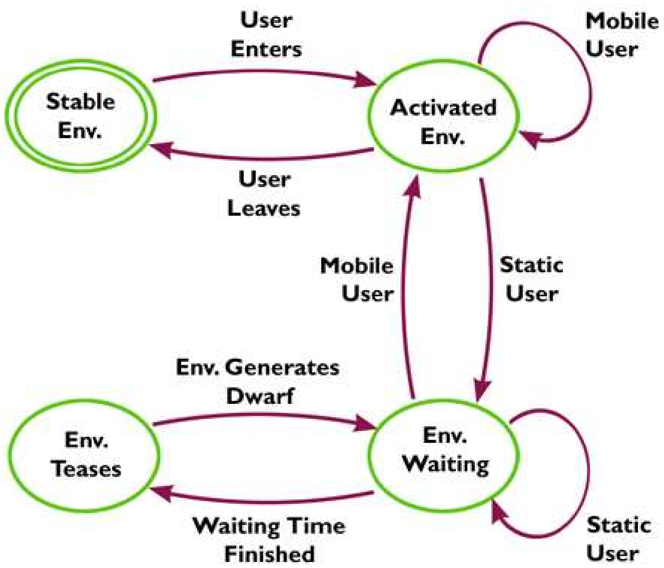


Figure 5: exampe of Fullaraca, one of the automata developed that describes the states that the model can have as a function of user interaction.

The system begins in a state in which all modalities –visual, sound, and tactile, await an action by the user. If, for instance, a child begins to play with the images on the screen, the automaton of the model of visual interaction will change state in order to immediately respond to the user. At the same time, the decision-making module will analyze the responses given by the user and as a function of how the interaction is developing will choose the best way of bringing about an active, creative attitude on the part of the child by favoring other modalities or by changing the visual responses. The automata for each mode are thus responsible for providing an immediate response to the user's actions and the decision-making module is responsible for analyzing the evolution of the interaction over time and for altering the responses of the various modes [see Figure 6].

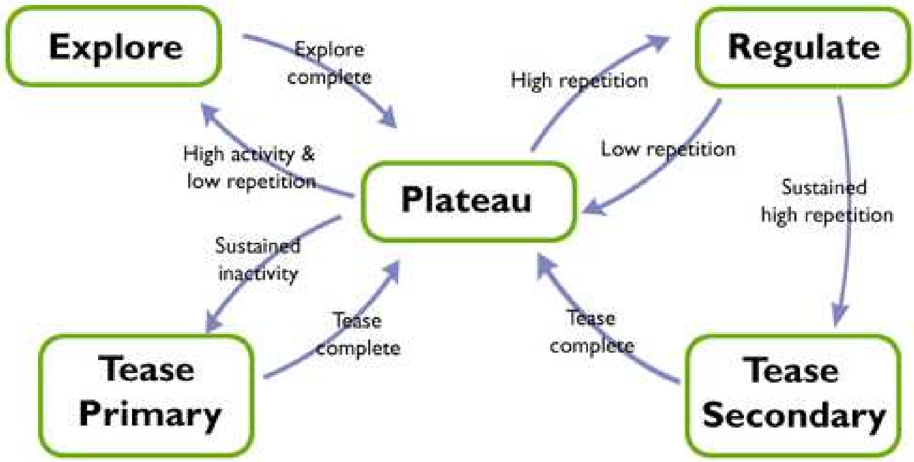


Figure 6: Automaton of the possible states in the decision-making module

Prototypes, informants and final interaction model

With the decision to work with particle systems in mind, and considering that it was impossible to define users, we began to propose an entire series of small visual games that could be set up with a particle system and with the responses that users could provide by interacting with their entire bodies. We call these communicative strategies interaction models; they define the visual elements, the guidelines for developing the strategy and the forms of use. From this initial list of small visual games we developed the four prototypes we named *Tatomo*, *Fullaraca*, *Kite*, and *Traçlen*. In each one of them we proposed different communicational hypotheses, different aesthetic and interactive solutions, that allowed us to do an exhaustive study of the system's possibilities.

To be able to adapt the best possible of these interaction models to the characteristics of the speechless children with profound autism who would be the end users of MEDIATE, we consulted the opinion of psychologists and informants, people with autism who are highly functional who helped us to try out and evaluate the prototypes. (13) From the evaluations done of each one of the prototypes we extracted the characteristics that were to be incorporated into the final interaction model, which we named *Motato*.

*The **Tatomo** interaction model*

The user finds the entire screen covered with square pieces distributed in a regular design. As the user moves throughout the space the particles rotate on their vertical axis, follow the user as it were, and continue to face the user's new position. The distance between the user and the screen changes the size of the squares –the further away the user is, the smaller the squares are and vice versa. When the user approaches the screen and touches it, there is a wave of color the flows outwards [see Figure 7]. If he or she touches the screen for a long time, the system produces successive waves of different colors that can fill the entire screen.

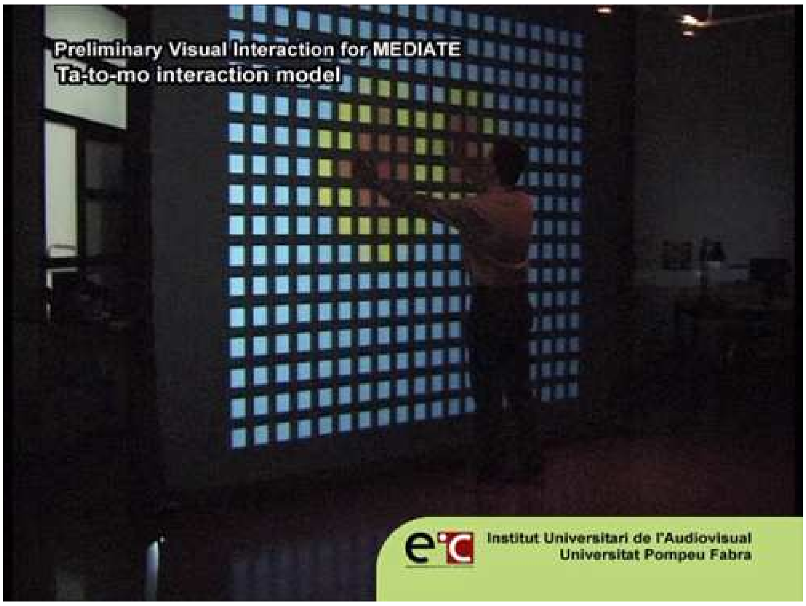


Figure 7: Image of the Tatomo interaction model. Response consisting of two waves of colors, produced by continously pressing on two points of the screen.

This interaction model provides a high degree of contingency and sense of control to users because of the clear action/reaction nature of its responses. The psychologists and informants gave positive evaluations to this model because it was clear and simple. It was considered particularly appropriate for very low functional level autistic children.

*The **Fullaraca** interaction model*

In *Fullaraca* users are proposed a game in which interaction with the whole body is important, both for moving about the environment and for moving the body itself (legs, arms, head and hands). In the initial stage, the lower part of the screen is completely full of particles that pile up on the ground, as if they were leaves. When the user gets closer, the particles move about the screen, as if there were an air current. As they loose force they begin to fall towards the bottom of the scrren. If they coincide as they fall with the projection of the user's silhouette on the scrren, their trajectory is changed and they either remain on top of the silhouette or fall to one side. If the users move in front of the screen again, they make more and more particles fly around and thus there are more particles that can move or accumulate on their silhouette [see Figure 8].

Figure 8: User interacting with Fullaraca

As opposed to *Tatomo*, *Fullaraca* incorporates a mechanism that encourages action. If the user is passive for a while, without moving or doing anything, pseudo-circular figures we call "elves" appear moving on the screen and cause the particles to move about and attempt to make the user curious, to make him or her react to the stimulus.

Even though we had considered the comparison of the particles with dry leaves piling up on the ground, the visual representation and dynamic of the interaction do not require the user to understand this visual metaphor and thus allow interaction with the set of particles as well as with an isolated individual particle. As with the other models, in *Fullaraca* the response begins when the user moves throughout the space. In this model, however, the density and complexity of the system's behavior can decrease the sense of contingency in low functional level autistic children. Incorporating the symbolic representation of the user's silhouette on a 1:1 scale was evaluated very positively and we decided to use it in the definitive interaction model as an important factor to reinforce the sense of agenthood.

*The **Kite** interaction model*

The *Kite* model gives priority to gesturing and movement of the user's body and arms. The entire screen is full of diamond-shaped particles. One particle that is different from the rest because it is bigger and a different color, known as the *kite*, follows the movement of the user's hand and body and gathers up particles as it moves, thus creating a chain or tail behind it. For example, when a child moves from right to left in front of the screen, the kite also moves from right to left and attracts new particles that add to its tail [see Figure 9]. In this model we use the position of the user's hands and head: the kite is controlled by moving the hand that is further from the body of, if neither hand is moving, the kite is controlled by the torso of the user's body. If the user remains still for a while, the tail of the kite begins to come apart and the particles slowly go back to their original positions.

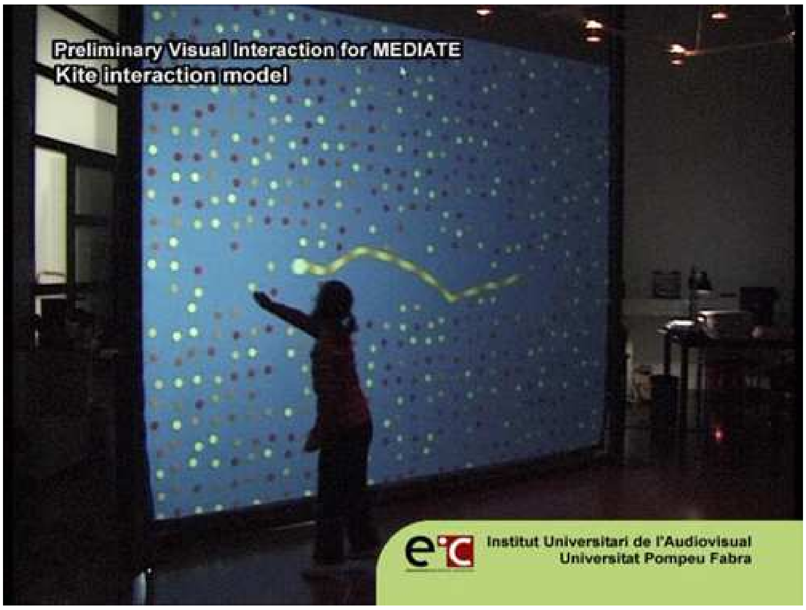


Figure 9: Interaction with Kite that shows the kite and the tail created by its trajectory on the screen.

The high potential for control and agenthood that this model implies might present too much of a stumbling block for children with severe motor limitations or difficulties, which are typical in cases of low functional level autistic persons. For this reason, we decided to not develop this model in the final interface.

*The **Traç/en** interaction model*

The *Traç/en* model aims to encourage interaction by means of small movements of the body, head, feat or hands. To do this it must distinguish these movements from larger movements around the environment. *Traç/en* presents a cloud or swarm of particles that fill the entire screen. The movements of the person in the environment define the direction the cloud moves in: when the user moves to the right, the whole cloud moves to the right; when the user moves to the left, the particles move to the left. Small movements of a part of the body in front of the screen freeze or capture a group of particles that change color, abandon the movement of the set and become an object that contrasts with the backgroundf [see Figure 10]. This contrasting, static object after a while begins to fall and move towards the bottom of the screen to slowly blend back into the cloud.

Figure 10: Swarm of background particles and figure shaped by isolating a small group of particles in Traç/en

This model, which reflects small movements and gestures, is responsible for the dynamic atmosphere of the environment because of the constant movement of all the background particles. It is the only one of the models developed to incorporate the concepts of texture and stain as attributes of the background, thus strengthening the perception of three dimensionality. As was the case with *Kite*, however, the fact that some children with motor disabilities might feel unsteady, together with the possibility of causing overstimulation due to the high degree of visual density, convinced us to not develop this proposal.

The last model: ***Motato***

The interaction model that we used in the end for the visual mode responds to the movement of the user in and around the environment and to changes in distance from the screen as well as to touching the screen. In addition, it envisons responses for other user actions such as sound production, steps on the floor, or touching the walls that have the appropriate sensors. The same model is implemented on the two screens in the space.

Initially, the screens do not have particles but rather simply a background color. When the user crosses the entrance, the screens fill up with a series of small squares that are distributed in a regular grid [see Figure 10]. When a child moves throughout the space, the changes in distance from the screen change the size of the squares on the screen: the squares become larger as the child approaches the screen, and decrease in size as he or she moves away. A small, light-colored square centered on the user's position greets the user and follows him or her constantly. Movement in front of the screen affects the particles in another way as well: the particles that correspond to the projection of the person's silhouette on the screen increase in size and change color so as to contrast with the rest. The increase in size makes the particles blend together to form a shape. The change in color also helps to differentiate a shape from the background. At this point in time, the remaining particles are seen as part of the background. In this way, the user sees the movements of his or her body reflected in the behavior of the particles on the screen [see Figure 11].

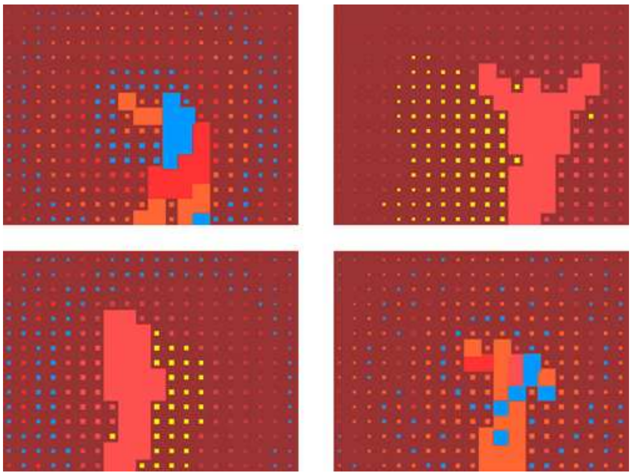


Figure 11: The user approaches the screen and the figure takes shape according to the projection of the silhouette.

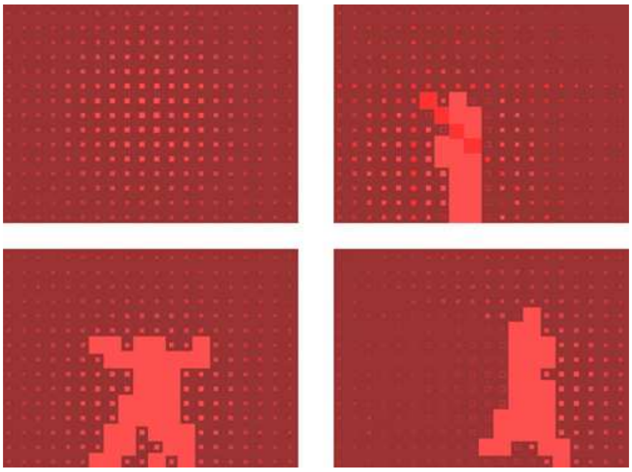


Figure 12: The person's silhouette and the waves of colors

If the participant touches the screen, the system responds by generating a wave that changes the color of the particles starting from the point of contact (as if they were the ripple of a stone thrown in a pool of water). If the user continues to put pressure on the screen, the particles generate successive waves of colors that fill up the whole screen.

The overall design of MEDIATE contemplates the decision-making module requiring that the interaction models increase their complexity in function of the evaluation criteria of user interaction with the system. In the visual mode we have planned for several variations on the responses described that are available within the decision-making module and are ranked according to level of difficulty. The decision-making module may also require the interaction models to respond in several different modes, in which case the user's actions in one mode could be answered with a response of the same type or not. In the case of the visual mode, that means that what is seen on the screen might be the response to interaction with the sound module or interaction received from the sensors sensitive to the touch. For example, if the person touches the vibrating wall, the visual mode could generate colored waves in the particles that are close to the point being touched. If the user touches the wall there are tubes that generate sound, a change in range could result on the screen. A voice or any sound emitted could make the particles revolve around themselves and change color according to the tone. Steps on the floor could result in the vibration of particles, etc. This level of multimode complexity, however, only intervenes when the user does not exhibit repetitive behavior due to the fact that it is much less clear and direct from the user's point of view.

Conclusions

The primary goal of MEDIATE was to help autistic children to acquire a sense of agenthood and control by means of interaction with the space, to help to advance their ability to express themselves and to enjoy themselves. In this sense, sessions with about a hundred autistic children in Barcelona, Hilversum, London and Portsmouth have been carried out. Each session lasted between 5 and 34 minutes. In all cases, we were able to observe that the children understood and played with at least one of the interaction models, even if it was only to enter and leave the environment to check the shapes and colors of the particles.

According to the psychologists, none of the children felt uncomfortable in the environment. There are three fields in which MEDIATE can make a positive contribution: user independence, adaptability of the system to the user, and the fact that no previous objectives must be attained prior to participation. The opinions of family members of children who have been users of MEDIATE are very encouraging, as they consider that the experience was positive and would like the children to continue to use the environment.

This project was carried out by the research team in Experimentation in Interactive Communication in the field of "Interactive Communication for Persons with Special Needs," but its results can be applied to all of our research in "Interaction with Digital Stimuli Generated in Real Time," as well as to the design of the Intranet and personalized DVDs in "Design of Author Interaction." This project has enabled us to better understand some of the properties of audiovisual communication that are specific (14) to Interactive Communication.

NOTES

(1) The definition of autism as well as what constitutes the category of profound autism with no ability to engage in verbal communicacion were agreed upon in the consortium based upon the input from the team of psychologists. Some of these ideas can be found in HAPPÉ, F. *Introducción al autismo*. Madrid: Alianza Editorial, 1998, who was the chief psychologist in the project.

(2) More information is available on the websites of the project sites:
- UNIVERSITY OF PORTSMOUTH RESEARCH. *Mediate* [on-line]. Portsmounth: University of Portsmouth, 2004.
<http://www.port.ac.uk/research/mediate/> [Consulted in December, 2004]
- GRUP D'EXPERIMENTACIÓ EN COMUNICACIÓ INTERACTIVA. *Projectes: Mediate* [on-line]. Barcelona: Institut Universitari de l'Audiovisual: UPF, 2004.
<http://www.iua.upf.es/eic/eic_site/eic.php?i=c&s=pr> [Consulted in December, 2004]

(3) Specifically, the original idea for MEDIATE stems from a group of autistic children's visit to the exhibit *Art Machine* that was a part of Glasgow 1990. The children were able to experiment with Ron Gessin's work *Tune Tube*.

(4) A stereotypical attitude is one in which there is constant repetition of gestures, body movements, or sounds, and constitutes one of the characteristic symptoms in the diagnosis of autism.
- AMERICAN PSYCHIATRY ASSOCIATION *Diagnostic and statiscal manual of mental disorders*. 3a. ed. revisada. Washington DC: American Psychiatric Association, 1987.
ISBN: 089042019X

(5) See, for example:
- EVANS, K.; DUBOWSKI, J. *Art therapy with children on the autistic spectrum: beyond words*. Londres: Jessica Kingsley Publishers, 2001.
ISBN: 1853028258.

- AUTISM SOCIETY OF AMERICA A*utism society of america: all about autism* [on-line]. Autism Society of America, 2004. <http://www.autismsociety.org/site/PageServer?pagename=allaboutautism> [Consulted in December, 2004]

(6) See, for example, the now classic texts compiled by Brenda Laurel:
- LAUREL, B., comp. *The Art of human-computer interface design*. Readign: Addison-Wesley Publishing Company, 1990.
ISBN:0201517973

(7) The definition of three core types of disorders, known as Wing´s triad , is the most widely used framework for diagnosing autism. See: RUTTER, M.; SCHOPLER, E. “Autism and pervasive developmental disorders: conceptual and diagnostic issues”. *Journal of autism and developmental disorders* (1987), no. 17, p. 59-186. Cited in HAPPÉ F. *Op. Cit*.

(8) See the following on interaction-driven design:
- PARÉS, N.; PARÉS, R. "An Interaction-driven strategy for virtual reality applications". *Abstract Proceedings of the VR World Congress*. El.pub, IST, EC. Barcelona: www.VREfresh.com, 2001.
- PARÉS, N.; PARÉS, R. “Interaction-driven virtual reality application design: a particular case: 'El Ball del Fanalet or Lightpools'”. *PRESENCE: teleoperators and virtual environments*. Cambridge [MA]: MIT Press, 2001. 10.2. v. p. 236-245.

(9) For information on Gestalt and its subsequent developments, see the following:
- KOFFKA, K. *Principles of Gestalt psychology*. London: Routledge, 1955 (reprint 1999).
ISBN: 0415209625
- ARTHEIM, R. *Arte y percepción visual*. 10 ed. Madrid: Alianza Editorial, 1992.
ISBN: 8420670030
- DONDIS, D.A. *La Sintaxis de la imagen*. 12 ed. Barcelona: Gustavo Gili, 1997.
ISBN: 842520609X
- KANIZSA, G. *Percepción y pensamiento*. Barcelona: Paidós, 1986.
ISBN: 8475094228

(10) PANOFSKY, E. *Estudios sobre iconología*. Madrid: Alianza, 1972.

(11) HAPPÉ, F. *Op. cit.*

(12) See, for example, FOLEY, J. *Computer graphis principles and practice*. 2nd ed. Reading [MA]: Addison-Wesley, 1990.

(13) We use the term informants and understand that their role is different from that that they may have in usability studies in which a group of end users test a product. Neither do we associate our informants with users who might aid in developing product prototypes in design processes that revolve around the user. It is not clear that the perception that a high functional level autistic person may have is similar to that of a low functional level autistic person. The favorable or unfavorable opinion provided by the informants has allowed us to reaffirm certain decisions and question others.

(14) GRUP D’EXPERIMENTACIÓ EN COMUNICACIÓ INTERACTIVA [on-line]. Barcelona: Institut Universitari de l’Audiovisual: UPF, 2004.
<http://www.iua.upf.es/eic> [Consulted in December, 2004]