Assistive Technology: From research to rehabilitation in the Lega del Filo d'Oro

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Abstract

For more than forty years, the Research Center of Lega del Filo d'Oro has been developing innovative programs using assistive technology. The research projects allows people with multiple severe sensory disabilities to, for example, communicate, control the environment and carry out daily activities.

Once the research project is completed, the activity is included in the person's life plan.

Furthermore, the use of assistive technology in research led rehabilitation service professionals to identify and manage more and more aids such as Makey Makey, Click4All, Big Mack, in learning, inclusion activities, etc.

Keywords: Assistive Technology; Deafblind; Multisensory impaired people; Rehabilitation; Daily life; Inclusion.

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1. Introduction

Literature has shown that many people, with different causes of disability (multiple sensory disability, neurodegenerative diseases or acquired brain damage, rare diseases), different needs and different educational-rehabilitational goals, who benefit from assistive technology can successfully move forward with learning (Lancioni, 2017).

Additionally, outcomes can be extended from users to their environment, like reducing the burden for caregivers, saving assistance costs for the welfare system and more (Davalli, Bitelli, Magni, Casaleggi, Malavasi, Montanari *et al.*, 2018).

The Lega del Filo d'Oro is an Association founded in 1964, recognized as a moral authority in 1967 and non-profit organization in 1998, which for over 55 years has been taking care of assistance, rehabilitation and reintegration into both family and society of children, young and adult with deafblindness and multisensory impairment. Today, the rehabilitation activities of the Lega del Filo d'Oro, are carried out in the National Center of Osimo (AN), as well as in the four other large Residential Centers and Territorial Services: Lesmo (MB), Modena, Molfetta (BA), Termini Imerese (PA), and five local branches, in Naples, Padua, Rome, Pisa and Novara.

The Lega del Filo d'Oro has always been engaged in the fields of research and experimentation, for this reason gave birth to a Reasearch Center at the headquarters of Osimo that, for over forty years, has been developing intervention programs, introducing in a systematic and continuous way, innovations on education rehabilitative intervention for deafblind and multisensory impaired people, with the growing support of assistive technologies.

Over the years, the Center has carried out numerous research projects that have enabled people with multiple sensory disabilities for example, to learn cognitive cause-effect skills, learn simple sequences, fill time in a functional, to access leisure activities, etc. (Lancioni, Singh, O'Reilly, Sigafoos, Alberti, Perilli *et al.*, 2020).

Specifically, since late 1990s, assistive technology has been progressively applied and throughout this time several research studies have been undertaken to teach people with multiple disabilities to orient technology with auditory cues to manage simple indoor traveling in the spaces of the Rehabilitation Center (Lancioni, Singh, O'Reilly, Sigafoos, Campodonico, & Oliva, 2008; Lancioni, O'Reilly, Singh, Sigafoos, Campodonico, & Oliva, 2009), to perform daily activities (Lancioni, Singh,

O'Reilly, Sigafoos, Boccasini, Alberti *et al.*, 2014; Lancioni, Singh, O'Reilly, Sigafoos, Alberti, Boccasini *et al.*, 2015; Lancioni, Singh, O'Reilly, Sigafoos, Alberti, Perilli *et al.*, 2018; Lancioni, Singh, O'Reilly, Sigafoos, Grillo, Desideri *et al.*, 2020), to communicate remotely (Lancioni, Singh, O'Reilly, Sigafoos, Oliva, & Campodonico, 2013), to use robots to switch from one job to another, etc. (Lancioni, Bellini, & Oliva, 1993; Lancioni, O'Reilly, & Campodonico, 2000; Lancioni, Mantini, & Groeneweg, 2001; Lancioni, O'Reilly, & Basili, 2001). The use of microswitch clusters has allowed people with very limited motor skills to manage active requests, have social contacts, make choices, etc. (Lancioni, O'Reilly, Singh, Oliva, Piazzolla, & Pirani, 2002; Lancioni, O'Reilly, Singh, Oliva, Piazzolla, Gatto *et al.*, 2006; Lancioni, O'Reilly, Singh, Sigafoos, Boccasini, La Matire *et al.*, 2016).

All the projects of the Research Center including assistive technology have always allowed people with multiple sensory disabilities to get out of isolation, to move towards inclusion, to be active and "authors/actors" of their actions, to communicate, and to control their living environment.

The professionals of the multidisciplinary teams of the Rehabilitation Centers of the Lega del Filo d'Oro, in order to be able to proceed in the identification of the most suitable assistive technology for the person, and to avoid its possible dropout over, seek to: 1) identify the most appropriate assistive technology for the person, according to his or her personal needs and characteristics, his or her objectives and the context in which he or she lives (school, family, work), paying attention to physical, social and cultural features of the environment in which it is located; 2) to assess whether there are obstacles which can hinder the correct use of the aid/instrument; 3) to define a specific teaching program, identify if there are factors that can support the use of assistive technology.

2. Generalizing and adapting the research to daily life and rehabilitation

The Research Center designs projects on the basis of identification of the overall and educational needs of people with severe multiple impairments. The results of different projects highlight some important indicators to consider:

- A move towards a significant increase in responses to the given tasks;
- Happiness indicators noted when the participants carry out the activities;

- Improvement in psychophysical well-being indicators in programs which include assisted; walking from environmental factors and functional activities;
- Positive feedback on measurement of social evaluation of the projects;
- Positive perception, both from care assistants and often also from families, of unexpected skills and potential in the activation of adaptive responses and learning, even in those with low-level functioning.

The "core" aspect of our research is the transfer of skills learned during the experimental phase to the context of everyday life. For each participant, the operational methods and technological aids used are identified and incorporated into an individual rehabilitation project.

The procedures which regulate the phase of transfer to the assistants who daily work directly with the person ensure at the end of the research project:

1. Implementation of the program with significant repetition of improvements and enrichment of the educational methods;
2. Assistance from research personnel to the educational assistants in the Center in all phases of transfer of procedural steps and technological aids. In this respect, it is often the project itself which is designed, launched and implemented in the context of the individual's life, ensuring a higher level of generalization, acceptability and facilitation on the way to adaptation to daily routines;
3. Monitoring (follow-up) of the outcomes of maintaining the learned responses and on the functioning of the technology used over several months.

3. Aims of research and contextualization

The criteria which research projects adopt, follow and satisfy the needs of clinical rehabilitation, in particular:

- Stimulation of adaptive body movements e.g. legs and arms, improvement of posture and changes in posture during daily autonomous activities, moving around, motor activities, etc. These objectives are also shared by the neuromotor and physiotherapy treatments. In this sense, the indications from the research results can support and improve an integrated rehabilitation approach, identifying reinforcement strategies and encouraging motivation and greater participation in treatment. Even someone in a wheelchair can spend some moments during the day in movement and at the same time

receive some gratifying stimulation relating to the movement e.g. music, vibrations, light flashes, cartoons;
- Functional activities, scaled from those easiest to execute to those more complex, supported by a range of microswitches; the possibility that individual or pair activities are identified, supported by sensors and appropriate reinforcements which guarantee levels of occupation and movement, avoiding pauses or distractions, becomes one of the most important resources in rehabilitation in some periods of the day when an assistant can supervise the actions of a group of guests carrying out a task;
- The acquisition of communication systems using adapted commercial technology, notably reducing the costs of technological devices, this way widening the range of people who can benefit from them in other contexts like the home, local services and schools (Lancioni, Singh, O'Reilly, Sigafoos, Boccasini, La Matire *et al.*, 2016; Lancioni, O'Reilly, Sigafoos, Desideri, Alberti, Campodonico *et al.*, 2019; Lancioni *et al.*, 2020).

4. Technological aids in the educational/rehabilitation context

The hardware and software programs created by the Lega del Filo d'Oro's Centers are truly innovative and make a valid contribution to personalized educational programs through functional solutions adapted to meet a guest's needs, which introduce new elements of practicability.

Below there are some examples from the many activities created, planned and implemented by the Research Center. They have been adapted, transferred and used in different situations in the educational/rehabilitation process dealing with daily activities (Lancioni, Singh, O'Reilly, Sigafoos, Alberti, Perilli *et al.*, 2017; Lancioni, Singh, O'Reilly, Sigafoos, Campodonico, Zimbaro *et al.*, 2018).

4.1. Recreation/play

Play-Corner: a system of entertaining games and stimuli which are activated by switches operated independently and autonomously by disabled people. It consists of a simple board set in a relaxing corner of the room with music. Materials used are: a panel with soft toys and objects attached to elastic and a set of switches connected to music and vibrating toys/objects.

Teaching how to use it employs a technique of prompting to associate cause-effect relationships for each switch and a 'fading' process of gradually withdrawing help. In the final phase of training, sensors are placed on the table and the person can activate their favorite stimuli.

Flash-box: a cabinet with a 22" TV connected to a play station. The videogame used is commercial interactive software (Play 3) which, through a web-cam on the screen, can pick up any body movement. The movements are enhanced by light displays, colors and animation e.g. an aquarium with goldfish which move according to the movements detected by the web-cam.

Master tutor: a program which uses a basic PC to create attention spans which get gradually longer through software which projects music videos, sketches, videos of the guest's own family or significant people and cartoons. Specific Hardware and Software programs were developed to realize the project. It consists of an application which can manage a time line in which different types of stimuli can be presented to the person at a specific moment for a set time. When the application is opened, a timer is activated which at the pre-set moment activates the chosen stimulus for the period of time indicated.

Possible stimuli are:

- Common multimedia files which are played by PC peripherals (sounds, images, films, etc.);
- Mirror activities through a web-cam normally available on a laptop which reproduces the movements of the user;
- Relays with external activators (eg. massagers, vibrating cushions, fans, phones).

The specially designed hardware means that up to 6 relays can be controlled via WiFi and the same number of activators can be connected to them and managed independently by software during user activity.

Initially the stimuli are programmed to present with alternating one minute of stimulation and one minute of pause. Then, on the basis of criteria showing the degree of mastery reached, the period of stimulation can be increased to a maximum of 45 minutes, with programmed pauses (Coppa, Melchiorri, Bianchi, Antonucci, Mangoni, Pierantoni *et al.*, 2013).

4.2. Cognitive skills

Makey Makey: is an electronic board, that thanks to a conductive surfaces, can recognize when these surfaces are touched by any part of the body. The board acts like a keyboard and depending on which part of the

conductive surface is touched it sends a signal through a USB cable to the device to which it is connected. It determines cause-effect relationships through the possibility of using a large quantity of materials which can be permeated by just a small flow of power, starting from water or any those materials which have the necessary constituent, like most fresh fruit, leaves, play dough and different liquids; metals, tinfoil, some gift wrapping paper. Some everyday products like conductive inks and textiles can also be used. For example, a small piece of tinfoil can be placed on the side of a wheelchair headrest and it acts as an effective sensor of head movements or placing a cube of colored play dough on the wheelchair step gives an equally effective sensor for activating a stimulus.

Click4All: is an aid which can be connected via USB or Bluetooth to a smartphone, tablet or computer. It allows the disabled person to interact creatively with the digital world. Up to 12 "touch" buttons can be created which transform common objects and conductive materials (eg. fruit, tinfoil, metal, cloth and conductive ink, etc.) into sensors which can be activated by touching or swiping (Lancioni *et al.*, 2019).

Big Mack or Switch: they are installed on the wheelchairs of some guests who have visual impairment and spastic tetraplegia along with a monitor which displays large, clear, well-defined photo stimuli connected to a speaker which names them. There is a switch on the table (Big Mack) which is used to confirm the expected response. The program automatically scans the presentation of the different audio/visual stimuli along with a situation which reinforces them (e.g. going for a walk, listening to music, etc.). The software shows the first stimulus, lighting up the outline of the visual stimulus. If the user does not press the switch, after a set time, the program passes to the next one using serial scanning from left to right. When the user wants to make a particular choice, they confirm it using the switch and the software opens a sub-menu (eg. specific music) and they can choose with the same selection method (Lancioni, O'Reilly, Oliva, & Coppa, 2001).

4.3. Communication

Scratch: is free software based on block programming language. It allows assistants to create interactive stories, animation, games, music and art. For example, with people who have residual sight, we can have a football field in the background, one of a library of images available, with a ball and follow a series of moves:

- When you press the Space bar

- The ball moves 10 steps ahead
- The ball changes color
- If the ball touches the blue line:
  - The shout 'Goal!' is activated
  - Applause can be heard
  - The ball returns to its original position.

4.4. Motor skills

For neuromotor compromised guests who cannot walk and have serious difficulty in operating gratifying stimuli/events autonomously, technology is used which associates pressing sensors to VOCA.

One recently designed example, where the method was validated in research during experimental training, is for a girl who does not see or walk. The objective is to stimulate movement in the legs through contact sensors and reinforcement.

The training for teaching it had 4 steps:

- 1st step: assessment of preferences from a selection of pleasing music;
- 2nd step: touch sensitive microswitches were placed on a stuffed cushion with wooden supports at the sides and put in front of the girl;
- 3rd step: the teaching procedure involves physical and verbal prompting with successive 'fading', to stimulate the continuous movement forward of the legs either at the same time or alternately. Software activates the music which stops if the microswitch captures a pause longer than 10 seconds;
- 4th step: during the maintenance phase, the girl showed positive pleasure indicators and autonomously activated the sensors, significantly and continuously increasing functional physical exercise (Lancioni, Singh, O'Reilly, Campodonico, Oliva, & Groeneweg, 2004).

Technological aids are helping severely disabled people more and more and guaranteeing them greater inclusion and a better quality of life.

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