Magic Glove: An Interactive Hardware/Software System to Animate Objects. An Exploratory Study in Rehabilitation Setting.

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ABSTRACT

The speech treatment for children with hearing impairment is a challenging task and much tiring. It is very difficult to keep up the standard of children's attention and collaboration. Instead, we have observed that the speech treatment is based on the repetition of object's name (i.e. toy, picture, etc.) that the children use in daily life. In this work we presented an interactive hardware / software system to animate the objects. It was used in the speech treatment for children with hearing impairment. In the beginning, the "magic tool" has been build as a 'magic glove' but in this exploratory study we have chosen to change its form, because the children was two female. Below it is described the technology and the exploratory study.

Keywords
Rehabilitation, hearing impairment, cognitive systems for rehabilitation, speech treatment, interactive system in disables children's play.

INTRODUCTION
In this paper we show an application of a prototype system that allows to "give life" to objects (i.e. toys, utensils, carpets, pictures, etc.). When subjects touch an object, through a "magic tool" like glove or wand (Fig. 1), the object react emitting sounds and/or visual stimuli. The system is equipped of authoring software to create interactive scenarios. A first application of the system has involved the speech treatment of a male child with cochlear implant. We have decided to build magic tool like a glove to make this treatment more attractive for child. Our work started from research collaboration between the Institute of Cognitive Sciences and Technologies of National Research Council (Cnr) and the private foundation Fondazione Peppino Scoppa, in Angri (Salerno).

Figure 1: the "magic glove" and the puppet with embedded electronic modules, the "magic wand" and the doll with embedded electronic modules.

The main project purpose has been to build an interactive system able to allow to speech therapist to animate objects and distribute them in some play environment. The speech therapist can use system to perform exercises of vocabulary acquisition and object based storytelling with the final goal of increasing exploration of children. Our system is based on: Rfid Tag, Rfid reader, authoring software.

We have used Rfid tag to make object reactive and traceable by software. An Rfid tag is a microchip combined with an antenna in a compact package; the packaging is structured to allow the Rfid tag to be attached to an object to be tracked. We have put Rfid tags in the objects, the tags were little and they did not modify shape and size of objects. To track the object in the environment we have used an Rfid reader embedded in a "magic tool" (wand or glove). An RFID reader is a device that is used to interrogate an RFID tag. The reader has an antenna that emits radio waves; the tag responds by sending back its data. After reading the system, embedded in the "magic tool", send information to computer via Bluetooth. The computer elaborates this information and reproduces sounds and/or visual stimuli. The core of our prototype system is based on software. The software manages the information coming from the "magic tool" via Bluetooth device, identifies the objects and reproduces sounds and/or visual stimuli. The software allows to speech therapist or users in general, to associate a media stimulus to each specific tagged Rfid tag object or to create a new stimulus. The users could record video by webcam or a voice clip by microphone and use this media as stimulus. To associate a media stimulus to a tagged object the user had to follow a procedure. First of all it is necessary to touch an object using "magic tool"; then the user have to click on "change button" by software menu, a new windows appears and now is possible to browse media files stored on computer. The user has to choose a file and to click on "save stimulus" button. The stimulus is associated to object. It is possible to delete existing stimuli, creating new ones, previewing a media stimulus. The software gave us information about the interaction of the player (subject) with the objects, for example how many times the subject had touched an object. In figure n. 2 is the screenshot of management software for Rfid tags and stimuli.
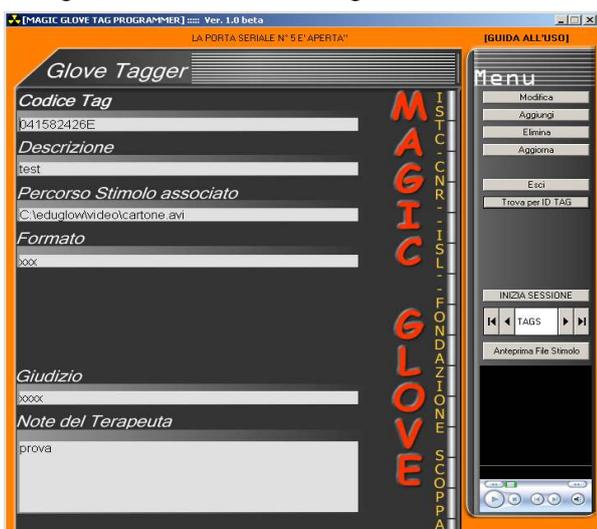

Figure 2: Tag management software.

In our opinion the application of this prototype could be considered open to user's need, it could be used in all way is required an interaction between subjects and objects. 'Magic tool' allows to create a treasure hunt made by responsive objects, to maintain high motivation to speech treatment, allowing subjects to come into contact with many stimuli in a playful and autonomous way. The child becomes an active partner who explores and manipulates objects of the environment and the latter interacts with the former by sounds and visual stimuli. 'Magic tool' could be described as a system that creates a circular link between subject, environment, action and perception. To explain this idea we have to read diagram 1 starting from the direction of green arrow. Reading diagram is possible to observe how the child touches object through a device like "magic tool", the object sends information to the software, the environment reacts with a sound sent by computer, and the child percepts this activation. The system has created a circular link between subject, environment, action and perception.
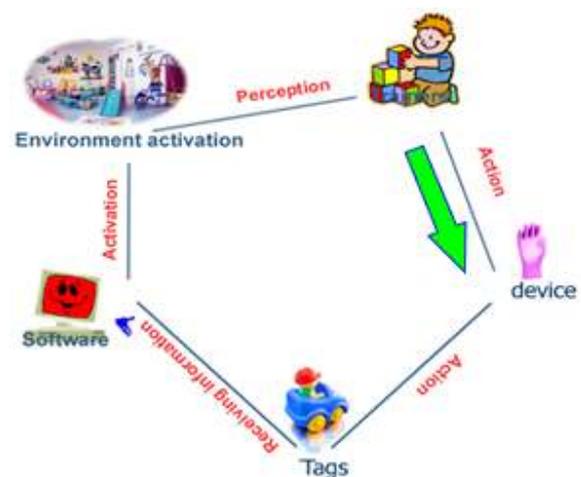

Diagram 1: Circular link

AN EXPLORATORY STUDY

The speech treatment for children with hearing impairment is a challenging task and much tiring. It is very difficult to keep up the standard of children's attention and collaboration. The children need to be stimulated steadily. The speech treatment is based on the repetition of object's name (i.e. toy, picture, etc.) that children use in daily life. During the speech treatment the therapist shows the object

to child and appoints it. The task of child is to repeat the object's name.

Observing some rehabilitation therapies, in the private foundation "Fondazione Peppino Scoppa", we have seen that in the first part of speech treatment child's attention and his collaboration was high, but after some minutes the child appears bored, not attracted by the exercise. For this reason, together with the speech therapist, Dr. Simona Riccardi, we have decided to tag some objects used in speech treatment and to install one computer into the setting room and to use the "magic wand". We have chosen some pictures to be tag, familiar or unfamiliar to child (i. e. a picture of feet, a picture of train, a picture of toothbrush, etc.). We have added two stimuli to each object, a sound stimulus (a voice that appoints the object, coming from the PC amplification) and a visual stimulus (a picture that shows the object on the computer's screen). As "sound stimulus", we have chosen therapist's voice, in this way the stimulus used should be more familiar and recognizable by the children. The quality of perceived sound is different if coming from human voice instead of electronic device. In fact, the patient must be trained to the listening of sound coming from electronic devices.

In this study, we have decided to make a comparison between their two individual cases, homogeneous by sex, age and condition. Both subjects are girls, they are 5 years old (Age Media = 4.5), and are respectively affected by acute neurosensorial bilateral ipoacusia and acute perceptive bilateral ipoacusia, the cause of the disease is unknown. In the phase of experimental planning it has been decided to use the "magic wand" just for one child. So, one child has followed the "classical" speech treatment, while other child has followed the speech treatment mediated by the "magic wand". We have chosen to carry out the exploratory study using the "magic wand" for just one child to test tool benefit in the speech treatment.

The main goals that have led the study have been the following:

1. Verifying if the presence of an object that activates change in the environment after its manipulation is able to catalyse the attention of the child on the rehabilitative tasks;

2. Observing if through a play based on repetition of objects' name and images' description manipulated by glove or touched by wand, it is possible to obtain an improvement of performance in phonetic capabilities of patients;

3. Trying out if through the use of our prototype is possible to maximize the patient's exploration inside the room where the therapy takes place in order to trigger a play of repetition and self-exploration.

We have used, to value the baseline of children, the Peabody Picture Vocabulary Test - Revised (PPVT-R) of Lloyd and Leota, M. Dunn. This test measures an individual's receptive (hearing) vocabulary and it provides a quick estimate of verbal ability or scholastic aptitude. The total score can be converted to an IQ score.

METHOD and RESULT

The study has been conducted in a private rehabilitation centre where the children have been regularly followed a speech treatment. All speech treatments have been video recorded to observe behavioural changes and reactions during the speech treatment both without "magic wand" and with "magic wand". The presence of an observer during the speech treatment has been avoided, in order to guarantee the ecological protection of the therapeutic setting.

The Peabody Picture Vocabulary Test (PPVT-R) has been administered to the children before the observations and in the end of it. The two children have obtained different values at the evaluation of baseline. From the first administration of PPVT-R, the child A has no achieved an useful raw score to compare with the equivalent standard score for her age. Even though, she is 4 years and 10 months old, she has not a receptive vocabulary appropriate to her age. Instead, the child B has achieved a raw score useful and so it has been possible to deduce an equivalent score for her age. This indicates that the child B has a receptive vocabulary appropriate for his age. For this reasons, we have decided to use the "magic wand" just for one child. We have chosen the child A, because she has presented a higher compromise of language. The child A has carried out the speech treatment with the "magic wand", while the child B has carried out the classical speech treatment. We carried out five observations for each child. All the observations have been analysed subsequently. For each child an observational card – evaluation has been completed. This observational card-evaluation has been chosen because it is useful to evaluate the neuropsychological functions of children. The original observational card – evaluation of Barthelemy, Hamereury, Le lord (1995) evaluated fifteen functions. In this study, we have chosen to evaluate some main functions, as i. e. Attention, Tone muscular, Association and Language. Each function has been defined according to different items. For each item it has been assigned a value from 1 to 5 (from absence of behaviour to strong presence of behaviour). Starting from the initial observations, the child A has showed a greater interest and an increase degree of attention during all the speech treatments. The child was visibly attracted by "magic wand", its way to arise in

therapy has changed. We have observed a change in her muscular tone. Indeed, in the first observations the child A has been more tense in her movements and in the use of the "magic wand", compared to the last observations. Using the "magic wand" for the child A it had been useful to know new words and to interact with the speech therapist. Regarding the child B it has been observed an increase of attention during all the observations. The child B has showed an appropriate level of language and ability for her age. At the end of observations we have administered the Peabody Picture Vocabulary Test (PPVT-R). The child A has not obtained a raw score again, but she has obtained a higher score, however better than the previous administration. The child A does not present an appropriate receptive vocabulary for her age, anyway she was able to respond to some new items. Regarding the child B, she has obtained a low score compared to the first administration, but she is still in her age group and has an appropriately receptive vocabulary.

FURTHER DEVELOPMENT

In the light of our preliminary observations the system seems to transform the speech treatment, surely it becomes more attractive for child. To assert if the prototype can improve the vocabulary's acquisition and catalyze subject's attention on the tasks we will plan to do new experiment with more observations. If the result of new experiment will confirm the hypotheses of exploratory study, we will consider the idea to create two different interface of software. An interface for the speech therapist, much more complete and an another one for parents, simpler to use. In this last case, the subject can perform the exercises at home and with parent's help.

Another use of the "magic tool" can be to create a playful experience creating a treasure hunt game using tagged objects, so to perform exercises for speech treatment in a play setting and using the common toys that child uses at home.

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