SOCIAL ROBOTIC IN THERAPIES TO IMPROVE CHILDREN'S ATTENTIONAL CAPACITIES

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Abstract: *This paper describes how social robotics can help to improve children's attentional capacities in order to help them in the educational processes. This research is focus in use a robot as a tool in the psychological therapies. There are some projects that have been made to improve the children social capabilities. This article describes some of these projects in order to explain how the social robotic has been used as a therapeutic tool. The final goal of this research is found a methodological way to use a robot not only as a tool but as an agent in the child therapy and also measure the improve of child attention. This research is focus in children between 7 and 11 years old that are attended a regular primary education.*

Keywords: *assisting robot, attention deficit, behavioral interventions, social interface, social robot, therapeutic.*
MSC2010: *97C20, 97C30, 97C40, 97C60.*

1. INTRODUCTION

Use robots in common task in these days are very popular. There are robots for almost every area of human development, such as industry, space, medicine, and education.

Social robots are able to establish different kinds of interactions with humans.

Use a social robot as a tool to help people to increase their social abilities or help to fix cognitive deficit is the goal for many researchers.

In this respect there are several social and assistive robots that have been development. Then some of them are mentioned.

Robots Kasper was created with social abilities to help children with autism, is a child size robot and has imitation abilities using physical bodily expressions, facial gestures, it functions as a platform for human – robot – interactions studies [1].

Robot Keepon is a minimalist social robot created to express emotions to interact with it, this robot is also used to help children with autism [2].

Leonardo robot is a MIT robot, it encourage people to interact playfully with it as if a child, this robot has organic appearance which means that it has its own creature appearance [3,4,5].

Papero is a personal robot development by NEC, it goal is interact with children; ti has functions as take care of children, dialogues and games [6]. Like these examples is possible to found more prototypes as robotics faces, or humanoids. The examples that were mentioned are shown in Fig.1.

Fig.1. Social robots

This article intends to demonstrate the hypothesis that using a social robot and particularly social interface is possible to stimulate children attentions in school years.

It is possible to use a social robot as part of psychological therapies as a complementary tool. In order to reach the goal of this research is necessary define Attention Deficit and Hyperactivity Disorder (ADHD). ADHD consist in persistent patterns of inattention and/or hyperactivity and impulsivity, which are severe and common in children in school years in it age and level of development [7].

To measure the attentional capacities of children a difference perceptions test will be used. With this test is possible to know the actual state of child attention, so it is possible to establish the necessary parameters to develop the social abilities of the social robot.

2. SOCIAL ROBOT

Robots become common in our society, is easy to see robots in almost every daily activities.

Robots in their beginning were developed to help humans to do hard and danger works. In these days is possible to talk about robots interacting, collaborating and assistive people.

Talk about social robot is talk about a physical entity embodied in a complex, dynamic, and social environment sufficiently empowered to behave in a manner conducive to its own goals and those of its community [8].

There are several ways for a robot to be social, and they are it social behavior and its physical aspect.

To reach the interaction is not enough to use robot with body, but is necessary the robot actively use their body and develop a kind of body conception; also is important consider that robot need to have a social intelligent [9].

Robots that interact with people used to have an anthropomorphic body and various sensors to interact with people in a natural way, they intend to be a partner to the human and interact with people in their daily life [10].

Cynthia Breazeal from MIT has classified social robot based on its applications but in all cases the robots has been anthropomorphized to reach the interaction and to do any action with humans, and also the robot design will change depending on the environment in which the robot will work and the complexity of the task [11].

The classification establishes 4 kinds of social robots that are: socially evocative, social interface, socially receptive and sociable.
A social robot also can help people to do some specific task, so is possible to talk about Socially Interactive Robot and Socially Assistive Robots [12].

2.1 Social Interface. Considering these parameters of Breazeal classification, to reach the goal of this research is necessary to use a Social Interface which use social signals and similar communication as humans to facilitate the interaction with people in a natural way. The robot need to have enough social intelligent to transmit the message correctly, and this should be complemented with body gestures, gaze and facial expressions [11].

2.2 Socially Assistive Robot. This is the intersection of assistive robot and social interactive robot, they share the goal to provide assistance to human and use social interactions to give this assistance [12]. Assistive robot can help humans to do hard task or to assist them in specific task, but if it is combine with interactions skills, is possible to have a better tool to help humans in a natural way and also interact with them.

Have a tool able to participate as an active part of psychological therapies with children is the goal of this research.

2.3 Anthropomorphize. In all cases, if a social robot is involved, is necessary to talk about physical embodiment [13]. Give a body to the robot implies anthropomorphize it.

The role of anthropomorphizes is not built a synthetic human, but design a system that has to function in our physical world and social space [14].

To reach the interaction goal is necessary to give human attributes to robot. Is important reach the confidence between the child and robot, and never fall in Uncanny Valley witch Mori define as level of apathy that robot wich is very similar to human like can cause [15]. To gain the child attention and confidence is necessary develop a robot that looks like a robot or toy, not like an animal or human been.

Epley define factors that need to be consider in order to anthropomorphize and they are [16]:

- Elicited agent Knowledge, is used as source of induction, and allows establishing similarities between non-human agents using appearance and movement.
- Effectance Motivation, this is given to the non-human agent to reach the ability to give sense to it actions

- Social Motivation, establish social relations with human beings and let it motivations be satisfied.

2.4 Characterization. A Social Robot need to be characterized depends on who will be it users and also depend on what kind of labor and social activity will do. The physical aspect will change drastically focus on the social goal, for example a guide robot never will looks the same as a therapeutic robot, and both of them will not looks the same than a robot to take care of healthy children. Choose the right characterization and embodiment will increase or decrease the social interaction and will determine the success or failure of the task.

In Fig.2 is possible to see all the necessaries characters to have a social robot that will be useful in psychological therapies with children.
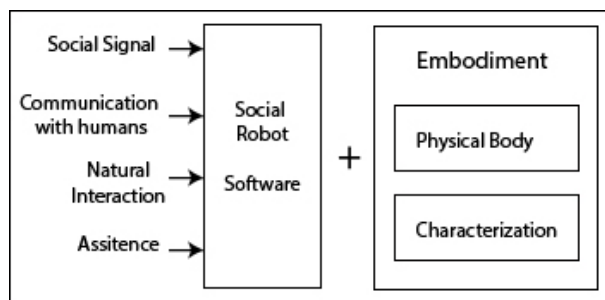
Fig.2. Characteristic for a social robot

3. ATTENTIONAL CAPACITIES

Attention is a basic psychological process. It is essential for the information processing and is related to other cognitive functioning, such as thinking and memory processes.

Luria define attention as an active process, not static [17], and is determined by a number of variables based on experience, interests, motives, and context.

This is a vital process for the optimal functioning of individuals in everyday life. The cognitive process that allows us to focus the organs on relevant stimuli to execute the activity; to focus attention on a stimulus voluntarily, others lose relevance.

For children at school age, attention is an important process. School age is a period ranging from 7 to 12 years old.

It is characterized by a set of changes in the psychological development of the child such as personality development; school becomes the context of socialization and acquisition of essential knowledge. At his phase conceptual thinking, conscious and voluntary nature of the cognitive processes, and greater stability in effective control, are development, this allows the child to adapt in the new social situation of development, characterized by the activity of study.

3.1 Attention Deficit and Hyperactivity Disorder (ADHD). The Attention Deficit and Hyperactivity Disorder (ADHD) consist on persistent pattern of inattention and/or hyperactivity and impulsivity, which are more severe than expected in children in school years [7].

The etiology of this disorder identifies several factors such as genetic, psychosocial, neurochemical developmental and neurophysiological. Although the causes are unknown, "many children with ADHD show no evidence of structural damage to the central nervous system. Contrastingly, children with known neurological disorders caused by brain injury do not have attention deficit disorder and hyperactivity "[7].

Among the psychosocial factors that influence the attention deficit in children are stressful events, dysfunctional families, and generators stressors.

American Psychiatric Association DSM IV has established some criteria for diagnosis of this disorder. These criteria involve inattention, hyperactivity and impulsivity [18] as shows in Fig.3.

Fig.3. Criteria for ADHD diagnosis.

3.2 How measure Attentional capacities?

To measure attentional capacities in children is necessary to use a special test. There are test like Toulouse - Piéron test, it consist in let the child watch 3 figures of the top and mark all figures that are the same, this should be doing from top to bottom and from left to right as fast as possible. Fig. 4 shows part of this test.
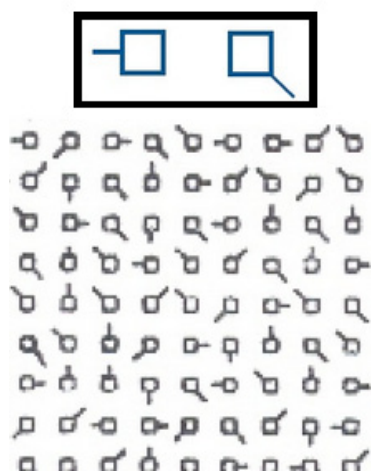

Fig.4. Toulouse - Piéron Test

Other test is Differences Perception test also called Face Test, this test assesses sustained attention and selective attention; it consist in determine which of the 3 faces is different and cross it off. Faces test has integrated 60 graphic elements that are schematic drawings of faces. This test will be used in this research because children will be tested, and because it has faces that can attract the child's interest in do the test. Fig.5. shows an example of part this test.
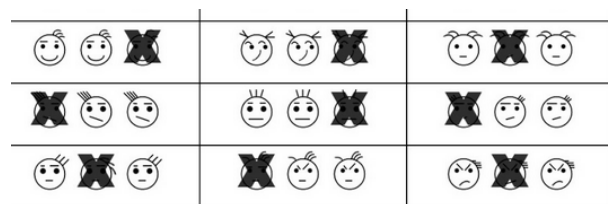

Fig.5. Differences Perception test - Face Tes0.t

With the result of the test, the specific population for this research will be identified and will be possible classified levels of attentions in the population.

4. ROBOTS IN ATTENTIONAL THERAPIES FOR CHILDREN

In school age increase the volume of care and attention span of the child, and this process, like the other cognitive processes becomes voluntary [19].

One of the problems that affect school children is attention deficit. "Attentional problems are persistent and occur frequently associated with other early problems" [20]. It is report that attention deficit / hyperactivity disorder increases the likelihood of developing aggressive and shy behavior, psychiatric disorders with disabilities, cognitive deficits and need for special education [20]. Help the child to overcome these disorders reducing the time of the therapy is the goal, and to reach this goal robotics offer a unique tool to developmental phycology and related disciplines in evaluating complex interaction models [21].

A social robot can be used as part of child therapy. The goal to use a social robot is accelerate the therapy proceed but never replace it or replace the psychology place.

The social robot that will be require is a Social Interface but at the same time a Social Assistive Robot, so combine both characteristic will be the key of the success.

4.1 Robot features. The robot must exhibit peer-to-peer interaction skills because it primary function will be socially interact with children. A robot able to do peer-to-peer interactions will have the following characteristics [22]:

- Express and/or perceive emotions.
- Communicate with high level dialogue.
- Learn/recognize models of the agents.
- Establish / maintain social relationships.
- Use natural cues (gaze, gestures).
- Exhibit distinctive personality and character.
- May learn / develop social competencies.

To create a robot with an intelligent and interactive behavior is important give to it verbal and nonverbal behaviors of humans, such as facial expressions and body language that accompany speech [23].

4.2 Joint Attention. Robot need to have the ability to do attention detection that is to track the attentional behavior and may imply follow the gaze; attention manipulation that allow it to manipulate the attentional behavior of agents, using pointing gestures or words; social coordination that let the agent be able to engage in coordinated interaction with other agents, this implies mastering social techniques such as turn-taking, role-switching and ritualized games [24].

In social psychology Joint Attention is a mutual manifestation and is the same as focus attention [25].

4.3 Computational model. To be able of construct a computational model of possible behavior of the robot is necessary define that the robot will answer to different kind of stimuli.

Balkenius and Björne describes if the stimuli S_i occurs, a response R_i will be generated.

The activation of the response is giving by equation (1) [18]:

$$\Delta R_i(t) = \alpha(1 - R_i(t))S_i(t) - \beta R_i(t), \qquad (1)$$

where

$S_i(t)$ is the input signal shunted by the current activity of the node and α describes the activation of α trace and
β describes the passive decay of the memory trace.

The context system inhibits associating from stimulus to response through a matrix M, which is described in the equation (2) [18]:

$$\Delta R_i(t) = \alpha(1 - R_i(t))S_i(t) - \beta R_i(t) - R_i(t)c_iM_{ji}, \quad (2)$$

where

M can be interpreted as the cognitive set of corresponding to certain contextual representation.

Olsen and Goodrich describes that are metrics that are possible to measure. This metrics are task effectiveness (TE) that measure how a human-robot team accomplish some task; Neglect tolerance (NT), measure haw the robot's current task effectiveness declines over time when the robot is neglected by the user; robot attention demand (RAD) measure how much attention a robot is demanding, this is a measure of the fraction of total task time that a user must attend to a given robot, see equation (3); free time (FT) is a metric related to RAD is the user's free time, is a fraction of the task time that the user does not need to pay attention to the robot, see equation (4); fan out (FO) is used to measure the effectiveness of a human-robots team, see equation (5); finally interaction effort (IE) is related to the time necessary to interact with a given robot, see equation (6) [26]:

$$RAD = IE / (IE + NT), \qquad (3)$$

$$FT = 1.0 - RAD, \qquad (4)$$

$$FO = 1.0 / RAD, \qquad (5)$$

$$IE = NT/(FO-1). \qquad (6)$$

Considering all this parameter to measure and the relationship between stimuli and response, it is possible to develop a successfully computational model of the robot behavior.

4.1 Intervention plan. The psychological and social intervention is essential to ensure good prognosis. The psychological intervention consists mainly in the formation of therapeutic groups where children are trained in social skills, assertiveness, where self-esteem, parent training is reinforced and behavioral interventions in the school and family context [7]. The therapeutic group will be conforming not only with children but with the robot also as part of the social group. In Fig.6. shows how would be the group therapy. In the group therapy the robot will interact with each child (with words, facial gestures and body movements) and will receive the answer of the children. In all process the psychologist will be present and will guide the different tasks.
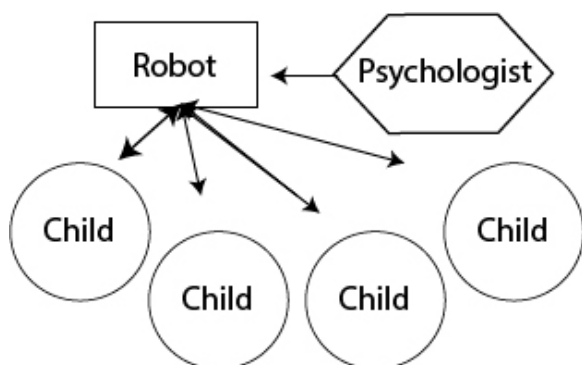

Fig.6. Diagram for group therapy

These interventions are characterized by strategies to improve symptoms of maladjustment through training in problem solving techniques and emotional self.

In his aspect the social robot can help to increase child esteem using dialogues and games oriented to reinforce the child attitude by congratulating all the good deeds.

Other strategies are aimed at targeting sports and leisure activities, orientation of associative simple to complex tasks related to school, such as the geometric representation of the school environment (classroom, pencil, notebook and tables). This activity will guide by the robot using it artificial vision to do object recognition and participating in a collaborative way with the children. In Fig.7 shows how will work the communication in a individual therapy, the psychologist will give the instruction of the task to the child and the robot.

To the child to explain the task that will be doing with the robot, and to the robot to make the example of the collaborative task that will be executed.
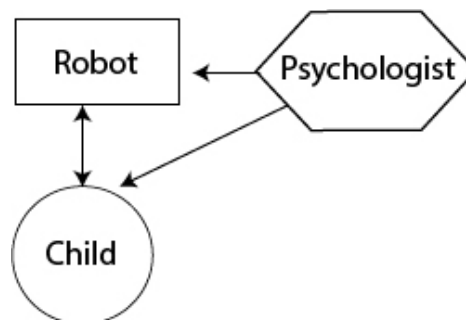

Fig.7. Diagram for individual therapy

Furthermore, in the carrying out of a special and unique activity (work with the robot) effectively, self-esteem and interest is reinforced by strengthening attention.

CONCLUSIONS

A social robot can be a powerful tool in physiological therapies with children. Because the child consider the robot as a toy or a friend and establish a close relationship with it, and therapy can progress quickly.

The robot can guide tasks, and their can gradually increase it level of complexity.

An example of this kind of task can be recognizing geometric figures and they add the task to recognize the figure color. Other task can introduce phrases, songs or games with phrases. Different kinds of therapeutic procedures can be made it using the body movements and facial expression that the robot has, such as imitations games that will work child coordination and imagination with associate elements such as coordination exercises.

This research is the beginning of the project in a primary school, and pretends to improve attentional capacity of children using a social robot in group and individual therapies.

As a futures works, we pretend to use the social robot with autistic children to help them to develop their social and attentional abilities.

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