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Investigaciones y Experiencias

Technical elements of social assistance robots that enhance the therapeutic or supportive effectiveness of the cooperative and communicative behavior of children with autism

Elementos técnicos de robots de asistencia social que potencien la eficacia terapéutica o solidaria de la conducta cooperativa y comunicativa de niños con autismo

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Resumen:

Las investigaciones de los últimos años muestran que el uso de la robótica puede ser una herramienta importante para mejorar la cooperación y la interacción social de los niños con autismo. De acuerdo con la revisión de la literatura, el uso de robots de asistencia social como ayuda puede traer beneficios significativos para el desarrollo de habilidades sociales en niños con autismo en áreas que muestran déficits subyacentes. En la presente investigación investigaremos las actitudes de los docentes sobre los elementos técnicos básicos de los robots de asistencia social que inciden y funcionan terapéuticamente en la mejora del comportamiento colaborativo y comunicativo de los niños con autismo. El análisis de los datos se refiere al efecto de las herramientas robóticas en la mejora de las habilidades de cooperación y comunicación de los niños con autismo en áreas como la capacidad verbal, el contacto visual, la reducción del comportamiento estereotipado de los niños, la imitación.

Palabras clave:

Autismo; robots de asistencia social; robótica; colaboración; comunicación; herramientas técnicas.

Abstract:

Research in recent years shows that the use of robotics can be an important tool in enhancing the cooperation and social interaction of children with autism. According to the literature review, the use of social assistance robots as an aid can bring significant benefits to the development of social skills in children with autism in areas that show underlying deficits. In the present research we will investigate the attitudes of teachers about the basic technical elements of social assistance robots that affect and function therapeutically in enhancing the collaborative and communicative behavior of children with autism. The analysis of the data concerns the effect of robotic tools on enhancing the cooperation and communication skills of children with autism in areas such as, verbal ability, eye contact, reduction of stereotypical behavior of children, imitation.

Key words:

Autism; social assistance robots; robotics; collaboration; communication;technical tools.

Introduction

Autism Spectrum Disorder is a neurodevelopmental disorder that presents with severe difficulties in social interaction, verbal communication, and some stereotypical repetitive behaviors (Fernell, Eriksson & Gillberg, 2013). It is a spectrum in which many difficulties appear in several areas, such as in the social field, the cognitive, emotional, motor, in the concentration of attention. Thus, children with autism find it difficult to communicate and manage social relationships, to understand their own feelings, but also the feelings of others or even to perceive body language. We also observe that these children have low levels of mental and cognitive functions (Lord & Bishop, 2010). Their speech is limited and in many cases, they do not have a complete and functional speech that is in accordance with their chronological age.

Educating children with autism is a difficult process, because it must follow specific programs, which must be repeated daily and be strictly structured (Lord & Bishop, 2010). Every child with autism has different needs and interests, as well as different skills, which is why you need to develop a personalized program tailored to the needs of each child.

Of course, various intervention methods have been developed for the education of children with autism. However, in addition to these traditional methods, in recent years special emphasis has been given to the use of new technologies in order to develop the skills of these children (Hersh, 2015). A review of the literature shows that the results obtained from the education of children with autism with new technologies are positive. Compared to traditional teaching methods, new technologies can visualize information in a way that is safe for children with autism, as it has consistent behavior without emotional transitions (Sng, Carter & Stephenson, 2020).

The synthesis from the results of other research shows that the use of new technologies in the education of children with autism is the appropriate learning tool and effective teaching intervention for children with autism (Hersh, 2015). When we refer to new technologies, we do not mean only the application of computers, but clearly all other technological means, such as smartphones, tablets, communication devices and various other tools that contribute to the educational process (Sng et al., 2020; Malliakas, Jiménez-Fanjul & Marín-

Díaz, 2021: Marín, Vagena & Rubio, 2020). Of course, we can see the utilization and the combination of old and modern tools by adapting our didactic intervention in the most effective way (Hersh, 2015). According to Mintz (2012) the utilization of many software, various educational tools, as well as a variety of activities have been created on various educational platforms and utilized by children with autism effectively meeting their educational needs.

The computer environment provides a high degree of predictability and consistency (Murias et al., 2018; Malliakas et al., 2021). There is specially designed software, such as virtual reality environments, that can present educational activities in a realistic and simplified way, providing social interaction and stress reduction in children with autism. Another important tool is "Video Modeling" and "Video Self-modeling", according to which a goal behavior is projected in a video and the student is asked to imitate the skills that have been displayed (Alexander et al., 2013). Finally, robotic technology is a continuous development in the field of education of children with autism. The design of social assistance robots has been done by scientific teams aiming at the most effective intervention of children with autism. The interaction of children with social assistance robots shows that robots can cause social behaviors (Zhang et al., 2020).

Robotics and autism

The effect of robotic tools on children with autism

The use of new technologies in recent years is a priority in modern and constantly evolving societies that want to enrich and evolve their education system (Alimisis & Moro, 2016; Parmy, 2018). Robotics, which combines elements of artificial intelligence, software development and the study of human behavior, is also considered a new technology. Educational robotics, therefore, is considered as a means of shaping computational thinking in students, developing their interest in technical creativity, focusing on the choice of engineering professions and technical technological specialties (Ahmad, Mudin & Orlando, 2017; Shcheidet, Goerlich & Kummert, 2017). Educational Robotics qualitatively enhances the learning of science in a playful way, thus improving students' interest in technology, creative activities and interdisciplinary problem-solving skills (Krichmar & Chou, 2018; Lydritis et al., 2019). The great advancement of technology, and especially in the field of robots, offers many opportunities for innovation and intervention for people with autism. The progress of recent years has allowed a number of human functions to be performed by robots but also to be able to help these robots to improve the social skills of these individuals (Fachantidis, Syriopoulou-Delli & Zygopoulou, 2018).

The application of robots aims to overcome the barriers of human interaction in education, as they can offer a more predictable and simplified form of communication to children with autism (Amran et al., 2018; Simut et al., 2016). This way children can participate in the activities more easily and feel more secure. Of course, robots should have some conditions that enhance the social interaction of children, such as having characteristics that refer to a human face, in order to make eye contact stronger (Tartarisco et al., 2015). A robot's reactions and expressions are less threatening and more predictable and controllable than the human face. Also, an important element is the movement and verbal interaction of robots, in order to develop cooperation and communication between the child and the robot (Tzafestas, 2016). Specifically, these technical elements of social assistance robots, such as eye contact, mimetic ability, reduction of stereotypical behaviors, verbal ability, enhance in a therapeutic or auxiliary way is effective in the cooperation and communication of children with autism (Yiannoutsou et al., 2016).

Eye contact is one of the most important research topics in children with autism. What the research of Severson et al. (2008) with the AIBO robot is that children with autism show increased eye contact during use with the robot, showed that the Cohen index ($d = 3.59$) is higher than the measurement made with the human partner ($d = 1.01$). Studies (Wainer et al, 2014) with the Kaspar robot have shown that eye contact with the robot was longer (> 47.3% of the total duration of the experiment) than with the trainer or in other directions (27.26% - 39.74%). At the end of the intervention, an increase in eye contact was observed in five times. But also, with the robot Nao in a study by Conti et al. (2015) showed that the child with autism maintains eye contact with it, while not turning his gaze to his trainer at any stage of the experiment. In another experiment involving 6 students with autism, it was observed that the children's eye contact with the presence of the robot Kaspar increased significantly, with the result that the students had eye contact with both the game and the instructor.

The composition of the results shows that the use of robots contributes to the development of verbal skills. Specifically, in the research of Pop et al. (2014) with the Probo robot studied the spontaneous speech utterance of children with autism during cooperative play without the presence of the robot was 73% with poorer performance. But when spontaneous speech was measured in another study by Huskens et al. (2013) with the presence of the Nao robot the students showed a positive performance. The research of Severson et al. (2008) with the AIBO robot showed that communication with the robot ($M = 2.73$ words per minute, $SD = 3.05$) was more increased than communication with a plush toy ($M = 1.07$ words per minute, $SD = 1.62$), ($Z = -2.073$, $p = .038$).

Also, in a study by Kim et al. (2012) using the Pleo robot the analysis of the results was done with t test (one-tailed paired t-test) and it was found that the participants produced more spoken speech with the robot ($M = 43.0$, $SD = 19.4$) compared to the presence only the trainer ($M = 36.8$, $SD = 19.2$, $t(23) = 1.97$, $p < 0.05$). Also, in both cases the reason was more than the use of a tablet device ($M = 25.2$, $SD = 13.4$). With the use of the robotic partner the verbal communication was greater when directed to the instructor.

Regarding the mimetic ability of children with autism with the use of robots, we find that these children can easily imitate movements and behaviors. In the research of Conti et al. (2015) with the NAO robot performed on three students, we observe that one student shows mimetic ability and interest, the second student failed to imitate the robot's movements, while the third student showed social interaction and mimicked the movements satisfactorily of the robot. We can also see a significant increase in this capacity in the research of Costa et al. (2015) with the Kaspar robot.

Play is an important need of the child and for this reason many researchers use it as a means of assessing the skills of children with autism. Thus, the use of robotics often becomes an essential tool for the development of play skills of children with autism. In the research of Pop et al. (2014) used the Probo robot in a sample of 11 students, greater involvement in the collaborative game was observed when there was the presence of the robotic partner in the group compared to the presence of the human partner ($U = 1.00$, $Z = -2.55$, $p = .011$ for the intervention phase). While in the functional game there was more interaction with the robot and participation in the activities, when the robotic partner was there with a statistically significant difference between the performances of the two teams ($U = 4.00$, $Z = 2.08$, $p = .037$ for the intervention phase) .

In the research of Severson et al. (2008) in a sample of 11 students, the AIBO robot was used and it was observed that the children showed more social behaviors, as well as developed more playing skills with the robot than with Kasha, a plush toy.

A characteristic of children with autism is stereotypical behaviors. According to Cohen, stereotypes and obsessions can reveal the interests of the child, which we could use, in order to reduce the rigid way, the child behaves, expanding his interests and enriching the range of possible alternative behaviors that will they could replace them. In the research of Pop et al. (2014) used the Probo robot in a sample of 11 students. ($U=4.00$, $Z = -2.05$, $p = .040$) which show a statistically significant difference between the two groups. In a study by Hana fiah et al. (2012) performed with the Nao robot, the child exhibited stereotypical behaviors for 2.5% of the total intervention time, while he showed 25% of the total performance time in the classroom.

Also, children with autism have difficulty interacting with others and showing spontaneous closeness and touch to others. However, the results of the research of Conti et al. (2015) in a sample of 3 students with the robot Nao showed that students' touch to the robotic partner does not occur as often in relation to other social behaviors. In the research of Costa et al. (2015) used the Kaspar robot, which has touch sensors and studied the possibility of touch intensity, showed that the number of gentle touches was 8.5 times greater with the Kaspar robot than with strong touches, while with the human trainer the number of gentle touches was 23.6 times more than the number of strong touches. What emerges is that the use of social assistance robots is through touch a way of communicating and approaching children with autism (Bharatharaj et al., 2017).

Methodology

The present study is a descriptive review of educational robotics and its educational intervention on children on the autism spectrum. We will explore the role of social assistance robots in educating children with autism, as well as exploring teachers' attitudes toward the technicalities of robotic tools and their importance to the cooperation and communication behavior of students with autism.

Objectives

As mentioned earlier, the main purpose of this study is to determine the intervention of social assistance robots in the education of children with autism, as well as to investigate the attitudes of teachers in relation to the technical elements of robotic tools and its importance in collaboration and communication behavior of students with autism.

- consider reducing stereotypes.

- explore whether social assistance robots can help enhance eye contact and gaming skills.

- identify how different characteristics of SARs can affect students with autism.

- to determine the conditions of social interaction from the use of robots in relation to the physical human presence.

- to consider the support of e-learning in the educational process, as well as the development of cooperative and communicative behavior, practice of perception, development of verbal communication, strengthening of cooperative and symbolic play.

Given the above objectives, the hypotheses are as follows:

Hypothesis 1: Teachers emphasize the reduction of stereotypical behaviors and the enhancement of mimetic skills through the implementation of a social robotics program.

Hypothesis 2: Supporting the educational process through the use of e-learning is a factor that contributes to the development of collaborative and communicative behavior, practice of perception, development of verbal communication, enhancement of collaborative and symbolic play.

Hypothesis 3: The contribution of SAR does not create alienation conditions for students with autism.

Sample

The sample, for the question of this research, consisted of teachers of secondary school general education in the area of Attica. 283 teachers, 144 (50,9%) men and 139 (49,1%) women with experience in special education, 147 teachers from all over took part. Finally, teachers have a bachelor's degree, a smaller part, 156 teachers, has completed a postgraduate degree, and 23 teachers has a doctorate.

Figure 1. Sample distribution according to studies Source: self made.

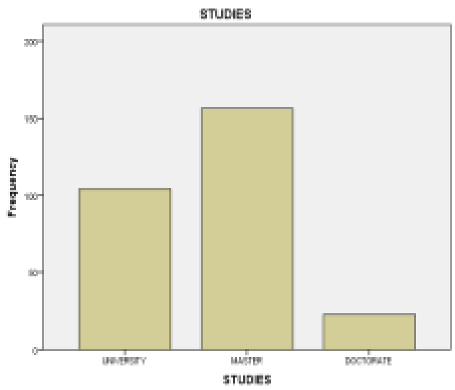
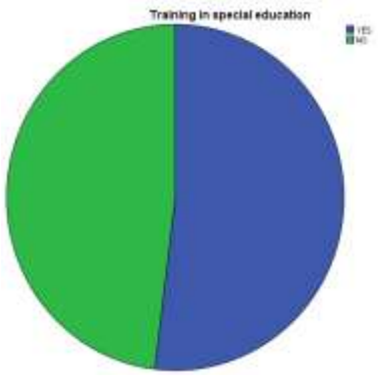


Figure 2. Sample distribution according to training in special education Source: self made.



Instrument

For the research question we select the questionnaire with which we will collect the information that will be given to us by the respondents. Questions will be closed-ended and individuals will be asked to answer by selecting a number from the five. Completing, encoding and analyzing data will be easier. Also, with the questionnaire, subjects are given the opportunity to answer all in exactly the same frame of reference. Participants were asked to complete an anonymous questionnaire that included 12 closed-ended questions from which teachers were asked to choose one of the suggested options. The questionnaire refers to teachers' views on the use of Social Welfare Robots in children with autism. The time required to complete it was 20 minutes and it was completed at the end of the course. The questionnaire is listed at the end of the text.

The type of questions will be of the closed type and will be the scale graded from the negative point to the positive and will be asked by the subject of the survey to choose one of the five.

The method of questioning will be done by visiting the researcher in a group of people, that is, at school. So we seek to involve many people in the research in a minimum of time and at the same time. We also have the possibility of clarification and more information to solve questions that may arise during the completion of the questionnaire.

***Instrument reliability**

The reliability of the questionnaire scale was calculated using the Cronbach alpha coefficient. From the Reliability Statistics table we have that the Cronbach rate is highly satisfactory (0.857). So, the 12 questions of the questionnaire compose a fairly satisfactory scale.

***Data analysis:**

The analysis of the data was descriptive to see the frequency in the teachers' answers and the percentage in each answer.

Results analysis

Descriptive study

Initially, the following tables give a picture of gender, studies, previous service in general and special school and the participation of teachers in training programs.

Table 1: Distribution of a sample based on gender and on the qualifications. Source: self made.

	Frequency	Percent	Valid Percent	Cumulative Percent
MEN	144	50.9	50.9	50.9
Valid WOMEN	139	49.1	49.1	100
Total	283	100	100	

The sample consists of 283 people, with 144 (50.9%) men and 139 (49.1%) women.

Table 2: Sample distribution based on the master's degree and doctoral details. Source: self made.

	Frequency	Percent	Valid Percent	Cumulative Percent
UNIVERSITY	104	36.7	36.7	36.7
Valid MASTER	156	55.1	55.1	91.9
DOCTORATE	23	8.1	8.1	100
Total	283	100	100	

According to Table 2, of the total number of participants (55.1%) have a master's degree and only 8.1% have a doctorate, while the remaining 36.7% have only a degree in higher education.

Table 3: Distribution of a sample based on training in special education. Source: self made.

	Frequency	Percent	Valid Percent	Cumulative Percent
YES	147	51 .9	51 .9	51 .9
Valid NO	136	48 .1	48 .1	100 .0
Total	283	100 .0	100 .0	

Also, Table 3 shows that 51.9% have specialized in special education, while 48.1% respectively do not have any specialization in special education.

In this section, a descriptive analysis of the answers given to all teachers will be presented for each question. Each question is given a table with the teachers' answers in descending order.

Table 4: Distribution of a sample based of the answers given to all teachers. Source: self made.

			N	%
1.	Eye contact can be increased a robot is used during the intervention.	Totally disagree		
		I disagree		
		Neither disagree -nor agree	122	43.1%
		I agree	161	56.9%
		totally agree		
		Total	**283**	**100%**
2.	Children with autism find it difficult to how more alternation of their eye contact between the toy and the partner after using the robotic tool.	Totally disagree	156	54.1%
		I disagree	117	42.4%
		Neither disagree -nor agree	10	3.5%
		I agree		
		totally agree		
		Total	**283**	**100%**
3.	Children with autism show increased verbal communication towards a robot.	Totally disagree		
		I disagree		
		Neither disagree -nor agree	135	47.7%
		I agree	148	52.3%
		totally agree		
		Total	**283**	**100%**
4.	Communication with the robot cannot increase the percentage of speech produced.	Totally disagree	128	45.2%
		I disagree	137	48.4%
		Neither disagree -nor agree	18	6.3%
		I agree		
		totally agree		
		Total	**283**	**100%**
5.	The mimicry skills of children with autism can be improved through robotic intervention.	Totally disagree		
		I disagree		
		Neither disagree -nor agree	176	62.2%
		I agree	107	37.8%
		totally agree		
		Total	**283**	**100%**

6.	When robots intervene in children with autism, there is a reduction in stereotypical behaviors.	Totally disagree		
		I disagree		
		Neither disagree -nor		
		agree	136	48.1
		I agree	147	51.9%
		totally agree		
		Total	**283**	**100%**
7.	The use of robotic tools helps to enhance play skills in children with autism.	Totally disagree		
		I disagree		
		Neither disagree -nor		
		agree	124	43.8%
		I agree	159	56.2%
		totally agree		
		Total	**283**	**100%**
8.	The participation of children with autism in the game increases and becomes more involved when there is a robotic partner in the team.	Totally disagree		
		I disagree		
		Neither disagree -nor	11	3.9%
		agree	118	41.7%
		I agree	154	54.4%
		totally agree		
		Total	**283**	**100%**
9.	Robotics is a more effective means of improving the social skills of children with autism in relation to human interaction.	Totally disagree		
		I disagree		
		Neither disagree -nor		
		agree	178	62.9%
		I agree	105	37.1%
		totally agree		
		Total	**283**	**100%**
10.	Children with autism do not exhibit communicative behaviors toward a robot.	Totally disagree	127	44.9%
		I disagree	148	52.3%
		Neither disagree -nor	8	2.8%
		agree		
		I agree		
		totally agree		
		Total	**283**	**100%**
11.	A social assistance robot is the means for children with autism to interact socially with other people.	Totally disagree		
		I disagree		
		Neither disagree -nor	14	4.9%
		agree	163	57.7%
		I agree	106	37.4%
		totally agree		
		Total	**283**	**100%**
12.	The use of robots when intervening in children with autism can utilize touch as a means of communication.	Totally disagree		
		I disagree		
		Neither disagree -nor	16	5.7%
		agree	128	45.2%
		I agree	139	49.1%
		totally agree		
		Total	**283**	**100%**

Table 4 above shows the percentages of answers to the scale questions given by the participants. There is uniformity in the answers without particular discrepancies between the respondents. Specifically, it is observed that in the question "Eye contact can be increased when a robot is used during the intervention" 56.9% completely agree and 43.1% agree with the question. Respectively to the question "Children with autism show increased verbal communication towards a robot" 52.3% completely agree. "Robotics is a more effective means of improving the social skills of children with autism in relation to human interaction" 62.9% agree with the question.

The use of robotic tools helps to enhance play skills in children with autism, shows us based on research that 56.2% completely agree. While, during the intervention with robots in children with autism there is a reduction of stereotypical behaviors and 51.9% completely agree.

The mimicry skills of children with autism can be improved through intervention with robots, 62.2% of participants agree. Children with autism find it difficult to show more alternation of their eye contact between the toy and the partner after using the robotic tool, according to this 3.9% seem to disagree or disagree while a large percentage of 54.1% completely disagree.

Communication with the robot cannot increase the percentage of speech produced, only 48.4% disagree. The participation of children with autism in the game increases and is more involved when there is a robotic partner in the team, 54.4% agree. 52.3% disagree with the question "Children with autism do not show communication behaviors towards a robot". It then seems that 57.75 disagree with the question "A social assistance robot is the means for the manifestation of social interactions of children with autism towards other people", while 4.9% do not disagree or agree. The use of robots when intervening in children with autism can use touch as a way of communication, 49.1% of respondents fully agree.

Analysis of variance (ANOVA)

To check if the average values of a quantitative variable differ between the categories of a qualitative variable when it has more than two categories, use the One-Way ANOVA. The ANOVA table shows if the dispersions are equal, in this case for the relation of the questions of the questionnaire in relation to the level of education of the respondents, it gives the level of importance $p < .05$. It is therefore true that there is a significant difference between dispersions. ($p = .000 < .05$), so there is a statistically significant difference. The first table presents the demographic characteristics of the control.

Comparing the two questions of the scale in relation to the gender of the participants, it was observed that there is a statistically significant relationship between the two variables examined. The first table contains the averages and the standard deviations of the values of the dependent variable of the two groups (men-women). In the second table the first line refers to the Levene test for equality of variations. Depending on the value of the significance of this test we accept the hypothesis of equal variations or not (here the power of the hypothesis of equal variations is 0.000, less than 0.05 so we accept that the variations are not equal. Therefore, we check the significance of the t-test in first line The power of the null hypothesis is π from 0.05 ($p = .000$) so the mean values differ between the two sexes.

To check if the average values of a quantitative variable differ between the categories of a qualitative variable when it has more than two categories, use the One-Way ANOVA. The ANOVA table shows whether the dispersions are equal, in this case for the relation of the questions of its scale in relation to the years of experience in the general education of the respondents, it gives the level of importance $p < .05$. It is therefore true that there is a significant difference between dispersions. ($p = .000 < .05$), so there is a statistically significant difference. The first table presents the demographic characteristics of the control.

Respectively commenting on the relationship of the questions of the scale of the questionnaire in relation to the years of experience in the special education of the respondents, gives the level of importance $p < .05$. It is therefore true that there is a significant difference between dispersions. ($p = .000 < .05$), so there is a statistically significant difference, and no differences are observed in relation to the above analysis with the years of experience in general education. The first table presents the demographic characteristics of the control.

Equally analyzing the post hoc table through Tukey´s HSD, there is a difference between the level of university education with postgraduate and doctoral. All other correlations are not different.

Discussion and Conclusions

Autism is a developmental disorder that is not treatable, but research is focused on finding and exploring ways to address it more effectively. Many therapeutic-educational approaches have been developed and implemented in order to improve autism deficits (Kucuk & Sisman, 2017). Of course, in order to apply each method of intervention, the special characteristics of each child are taken into account. Each child is unique and can combine different elements of autism than another. This is, after all, the peculiarity of this disorder, that it appears with different characteristics or a combination of them in each person. Thus, each intervention must be individualized and adapted to the needs of each individual child.

So a different way of approaching autism is through robotic tools, which are called upon to interact with autistic children in order to improve many of their disabilities (Mengoni et al., 2017). Thus, in this research, the attitudes of teachers regarding the effectiveness of the technical elements of such a tool in cooperation and communication skills are presented.

As a social mediator a social robot can serve as a mediator between the child and the therapist, educating the child with social skills in order to extend learning behaviors to the child's social peers (Mengoni et al., 2018). Children with autism, unlike normal developing children, cannot learn social skills over time, as their interaction with their environment is severely impaired (Parmy, 2018; Ricks & Colton, 2010).

For the development of communication behaviors, which is one of the main goals of interventions in which social assistance robots are used, educators argued that the use of robotic partners can cause the appearance and maintenance of eye contact (Krichmar & Chou 2018; Severson et al., 2008). The joint action of two people looking at the same target with the eye of the eye or pointing with gestures. The ability to maintain focus on a single object is naturally inhibited in children with autism, causing particularly common attention activities for them. During child-robot interactions, the robot is used to guide the child's attention to a specific object so that the child can easily follow the robot's direction (Murias et al., 2018). This is due to the fact that robots are a kind of toy, which makes it a more attractive game for children, as well as increasing the ability of children with autism to direct their gaze from an object to a person when using robotic tools.

Regarding the development of verbal communication, most educators believe that the use of the robotic tool can contribute to the development and development of speech in relation to the intervention of an educator (Shin & Shin, 2015; Pop et al., 2014). Also positive were the results regarding the mimetic ability of children with autism, which can be improved through robotic intervention. Imitation activities contribute to the development of a mapping mechanism in children (Conti et al., 2015). They also improve hand-eye coordination and enable children to recognize the people around them as social peers they can emulate (Costa et al., 2015). A robot teaches this ability to a child, involving him in simple imitation games, which, if performed successfully, allow the child to receive sensory reward and encouragement from the robot.

Also positive are the results of research that the use of a robotic tool can lead to the manifestation of less stereotypical behaviors during the game, compared to the execution of the game by the trainer (Pop et al., 2014; Costa et al., 2012). It is also a fact that children with autism have difficulties in the play process (Severson et al., 2008). According to the present research, as well as a number of other studies, it is argued that the use of robotic tools enhances play skills, as well as increases and engages the child in the group when there is a robotic partner (Wainer et al., 2014).

Robots enable built-in interactions. Due to their natural capabilities, interactions involving tactile exploration and physical movement make robots more attractive and interesting to a child (Conti et al., 2015). Robots also support naturally complex interactions, including gestures, speech and touch. The possibility of contact is lacking in the treatment through virtual characters and software agents, which gives the robots a remarkable advantage. Virtual therapy sessions include situations that require the use of speech, sounds, points of view and movement of the child, which makes robots more attractive (Costa et al., 2015).

Research review shows that there is a positive effect of robotics in enhancing the cooperative and communicative behavior of children with autism. What we find is that robotics can complement the process of planning, implementing, evaluating an intervention in children with autism. In no case can an instructor be replaced by a robotic tool,the presence of the former is necessary to control and guide the student's intervention.

Contribución de los autores

The author is responsible for the entire study.

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Not applicable.

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