Milo: Social Robots Helping Children with Autism

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Introduction
Social robots have become progressively relevant in our daily lives through their seamless integration into society in efforts to increase the wellbeing of individuals. A new generation of social robots used therapeutically to assist individuals with disabilities has become increasingly popular. Therapeutic robots are now being used with children with autism, helping them learn appropriate social behaviors and understand expressions and gestures. There have been many developments of therapy robots, but some have become more popular than others. One of the most popular therapeutic robots is Milo. Created by a company called RoboKind, Milo teaches social skills to children with autism through playful interactions and communicative visual, audio, and gestural actions. Milo fluidly combines social behaviors with technology through a unique interplay of a robot teaching a human how to behave. Though there are controversies concerning these therapeutic robots, there are many future implications and directions of the use of social robots to further our own ability to engage in the world. The report discusses the content and context of therapeutic robots, specifically Milo’s creation, delving into the history of therapeutic robots, the technological components and use of Milo, controversies and debate, as well as future implications.

The History of Social Robots
The creation of social robots has been a trend in human history for many centuries now. It began with robots that were created to mimic human behavior, like dancing and writing, but as the years have gone by, this definition has evolved into robots that have their own intelligence. This is where artificial intelligence (AI) becomes key. It has enhanced the possibilities of social robots from the simple and mechanical dancing to robots that now have the intelligence of humans, whether that is programmed into them or learned on their own. Trying to program the intelligence of these robots started off with needing it to have sensorimotor and for it to understand the space around it (Dautenhahn, 2007). Robots were then created and prototyped to move and react to the environment around them.

The next advancement that was made to these robots was the addition of behavior. This meant that the robots would be able to understand cues that they understood human emotions and were able to react back to humans by being able to reflect a responsive emotion. This is where the example of Kismet comes in. Kismet is a robot that was created to communicate with humans in a natural human way by taking in visual and auditory cues and then reacting to it by the behaviors that are programmed into it. Kisanet would react to the human behavior input it received by moving it’s eyebrows, eyes, mouth, and ears. This was programmed into the system as well was one of the first phases of practicing showing human behavior on a non-human object. This led to more experimentation and practices of understanding human behavior and researching it so it could be easily understandable and represented (Breazeal).
Due to the research and development that was put in over the years, researchers believed that there was more potential for what these robots could be capable of and this is when the idea of therapeutic robots became more prominent. Robots have been created to help with many different levels of comfort from comfort to loneliness and even helping with mental illness issues (Weir, 2015). Paro has created a soft interactive seals that helps relieve the stress of patients by having auditory, touch, and light sensors that allow it to react by moving its body parts as well as make noise to create the illusion of being alive that helps to relieve the stress of a patient (PARO). This is one of the earlier and more successful ways therapeutic robots have been successful in caring for humans and the next way that will be pointed out will be the focus of this research paper which is helping teach behavior to children with autism.

The Beginning of Milo

Autism is a condition that children are born with where they may face different challenges to different degrees of social skills and communication with others. There is a spectrum for where a person can have autism to a different degree and many people have this diagnosed around the age of 2 or 3. In the United States alone, 1 in 42 boys and 1 in 189 girls are diagnosed with a form of autism (What is Autism?). Autism is not curable but it can be treated so the symptoms are not as harsh but along with autism, other health issues can occur like seizures, sleep disturbances, anxieties, and multiple other possibilities. The main common differentiator for people with autism is that they tend to avoid contact with other humans and isolate themselves to their own world. This is due to an innate system in their brain where they avoid learning about from the interactions they have with their parents from an early age. The brain develops a repository of learning to understand how to react to multiple situations with people when a person is young from the everyday interactions with parents and others when a baby but this does not occur for those with autism. So as the years progress, interaction with others becomes minimal because they are unused to such interactions (Social Issues). This is where therapeutic robots have began playing a bigger role in the lives of these children to help them practice these skills.

The first robot that has been underworks since the late 90’s is Kaspar. He is a robot that interacts with children with autism in a way that gives them exposure to different behaviors, facial expressions, and active scenarios that would allow them to practice behavioral traits that are common for everyday situations. Kaspar has been created to be extremely human-like with the body and facial features of a child that would appeal to other children. Kaspar has been used in schools, homes, and hospitals to work with the children with autism as well as those who are involved in the child’s life (Kaspar the Social Robot). This overall creates a more natural environment for the children to learn more about their emotions and encourages them to interact
with others more often. This research and advancement of Kaspar has been revolutionized more by the creation of Milo. Milo was created with the same goal as Kaspar, to help children with autism develop behavioral traits, but with upgraded technology for how children are able to interact with him as well as an upgraded curriculum created based off years of research.

The Technology Behind Milo

A startup called RoboKind created Milo, a social robot that acts as a teacher or therapist role for learners with autism to learn communicative and behavioral skills in a more approachable way. Milo revolutionizes therapeutic efforts to care for children with autism by delivering social lessons through modeling human facial expressions and movement (Robots4Autism, 2015). Through curriculum formulated with diverse research from Robots4Autism, Milo exhibits an engaging and comfortable situation where children are able to learn more easily. Milo teaches K-12 students appropriate social behaviors through fluid social expressions and tone of voice, breaking barriers through delight as many children with autism tend to feel uncomfortable with eye contact and interactions with humans (Acapela Group, 2015).

There are many key features that sets Milo apart from other social robots used in the therapeutic field. As shown in Figure 2, Milo is a rather large and upright 2-foot tall robot that has dark brown hair and a friendly face, wearing a blue spacesuit that appeals to children in his quirkiness. He speaks 20% slower than an average human and also does not tire easily as he can repeat the same phrases many times without frustration to allow children with autism to understand what they are being taught (Corby, 2015). Milo is unique in his seamless social interaction that mimics human expressions and intonations, specifically in his voice. His expressive and exaggerated facial expressions are very important as individuals with autism often have an inability to read and connect with emotions of others (Tucker, 2015). His voice is critical to reflecting his personality and connecting with children through advanced technologies using speech solutions offered by a company called the Acapela Group that includes real children’s voices (Acapela Group, 2015).
As Milo can respond to voice interactions and expressions, there are several innovative technologies used to create his lifelike and real responses to help create a realistic experience. Milo has internal HD cameras in his eyes that record feedback such as amount of eye contact, response rate, and interest level from the child (Firth, 2015). Milo also has a 2.4-inch LCD screen mounted in his chest that shows picture symbols of vocabulary to keep children visually stimulated and focused. There is an internal computer in Milo that programs his movement and intelligence as well as specific curriculum for different children, which is connected to microphones to allow verbal interactions (Anderson, 2016). He also has sensors located all over his body and facial recognition software to further monitor the progress of the child for the therapists to review later (Firth, 2015). Milo has nine capacitive touch zones and six sensors placed all over his body from his head to his toes to gauge the movement and touch of the child for furthered interactions (RoboKind, 2015). He is able to move his legs and arms using motors to show gestures as well, which is valuable for children to learn appropriate social movements. The use of such sophisticated technology not only serves to engage the students so that they are actively participating with Milo but also allows Milo to react and monitor the students to help them learn each lesson uniquely for them.
RoboKind developed a program called Robots4Autism along with Milo to sell to schools for children with autism, depending on different skills that they may want to work on. As shown in Figure 3, in school and therapy settings, Milo sits one-on-one with a child and acts as a teacher (Abril, 2016). Milo teaches lessons verbally utilizing symbols on the screen on his chest to visually stimulate the children to help them learn better. Children use an iPad to answer questions such as identifying an emotion shown from Milo through multiple choice as many children with autism are nonverbal (Abril, 2016). Children can also have a chest monitor strapped to their chest that records their heart rate to reflect certain emotions they may be feeling as well (Tucker, 2015). A therapist or teacher can also be present to facilitate if necessary and to monitor the child’s progress, but only takes a passive role as Milo acts as the teacher instead.

The goal of the lessons are to help children understand social situations by breaking them down in terms of expressions and emotions so that the children will model these behaviors. The curriculum includes lessons like understanding facial expressions, predicting emotions of others, practicing healthy friendship relationships, and even learning how to be a great guest at a birthday party (Firth, 2015). These lessons help children learn necessary social behaviors by practicing with this tireless robot repeatedly to allow them to learn at their own speed. As it can be difficult to keep children with autism focused, Milo keeps individuals interested with his audio, visual, and gestural outputs that entice the children delightfully. Children are able to playfully interact and connect with Milo on a more personable level as his quirky facial expressions and recorded voice are modeled to those of a child as well.
There are many studies that have shown the success of Milo for children with autism as a use of therapy. In a study in South Carolina, autism specialists working with Robots4Autism saw that the program had helped many students to express and regulate their own emotions, calm themselves down which reduces behavioral problems, maintain eye contact, and participated in two-sided conversations appropriately (iESD, 2016). Researchers also found that Milo is best utilized for children who are able to recognize picture symbols, answer yes and no questions, and understand cause and effect (Firth, 2015). These skills are valuable for individuals with autism to help give them independence in their interactions with others without the direct pressure from a therapist or teacher.

Currently, there are seventy Milo robots used in schools and treatments centers with the majority of them in Texas and the rest in American and European universities (Firth, 2015). There are even some families that have bought their own Milo robots at their homes as well (Firth, 2015). Though it can cost up to $22,000 a year to educate a child with autism, Milo robot and the curriculum costs $5,000, which can save money for families and schools in places where therapy is too expensive (Firth, 2015). Overall, Milo currently assists and successfully helps children with autism learn new valuable social skills to utilize in the real world. Though Milo does not fully replace human therapists, this robot can be used in conjunction with therapy to assist therapists and teachers for children who are nonresponsive to adults. Milo benefits children to self regulate their emotions and understand social cues and expressions to help towards a future of more inclusive and accessible learning environments.

Controversies of Therapeutic Social Robots

Therapeutic robots have been well advanced to have lots of possibilities. However, it is believed that it took a while for robotic therapy to become mainstream (Chow, 2014). Using interactive robots to help patients has made some accomplishments, but concerns still remain. Given that there are many major issues and ethical implications that come along with it, people are still skeptical about embracing robotics. The issues include the loss of human contact, level of autonomy and control, lack of privacy.

Loss of Human Contact

One of the primary controversies that arises along the topic of therapeutic robots is the reduced amount of human interaction. The software program of therapeutic robots are developed based on the daily activities of people who need special care, and these robots are able to handle tasks in multiple areas. For instance, therapeutic robots used for treating children with autism are designed to assist in play, food, and hygiene activities (Hetzroni et al., 2004). It is helpful to employ robots to carry out the tasks, easing the burdens of carers and therapists; however, there
is a problem. The usage of robots in either therapy or care might result in decreasing amount of social contact. Even though some of the tasks can be dull and time-consuming, they actually provide a great chance for connecting with other humans. According to Sharkey, using robots to perform tasks that could have been done by human assistants “would remove a valuable opportunity for social interaction” between patients and human caregivers (Sharkey, 2012).

On the other hand, robotic technology has been greatly enhanced which potentially conveys a misleading message that robots can relate to humans, causing the increase in a loss of human social contact. Developed robots are built with many sensors, which enable them to detect a person’s emotional expression. Robots serving as a therapeutic tool use cameras to capture facial expressions to measure the emotions of children with autism. With the powerful sensors and learning ability, robots are able to respond in an appropriate way to the emotions they recognize. Since robots are advanced to mimic human behaviors by responding with social gestures, they seem to be approachable and “give the illusion of sentience and understanding” (Sharkey, 2016). Consequently, the line between reality and imagination becomes blurred. People who are treated can heavily rely on robots and lose normal social contact with other humans. If that is the case, individuals with disabilities, like children living with autism, might demonstrate some improvements in the virtual environment but not in an actual social environment. Also, reduced social interaction can have a substantial impact on the health and well-being as building relationship is an important aspect of being a human (Simpson, 2016).

Level of Autonomy and Control

The issue of autonomy and control is certainly a highlighted ethical concern for therapeutic robots. When it comes to the notion of replacing human therapists with therapeutic social robots, the approval rate is lower than expected. Comparing to the data with 47% agreeing and 39 percent strongly agreeing in using social robots in therapy for children with autism, there is only 19% agreeing and 8% strongly agreeing that it is acceptable to fill the role of human therapists with social robots (Chow, 2014). People are unsure if robots can be permitted to have authority over humans, taking the responsibility solely without human supervision. Scientists and researchers have been pushing boundaries to build cutting-edge robots that have greater capabilities and controls to undertake more tasks, but it can be problematic if robots are in an influential position. Super powerful and autonomous robots can cause humans to lose control over them, and is an issue that who should be responsible for the robot’s actions and behaviors.

Additionally, despite the fact robots are composed of numerous features, they do not possess a human brain, which is far more complicated with high levels of connectivity (Lucaciu, 2013). Therapeutic robots were initially developed to facilitate the process of treatments. The idea of giving robots more controls instead of simply being in an assistive position is questionable. It is
concerning that if robots can make a just decision at crucial points as they are not able to integrate information with the same efficiency and empathy. An argument is that robots can be even fairer than humans because they are machines with no emotions (Sharkey, 2016). Yet, it raises another problem whether a robot can truly meet the emotional needs of people being cared if it has only sensors and a computer system. Therefore, the idea of robots being in charge of therapy and healthcare remains debatable.

_Lack of Privacy_

The more social robots are applied to reach to a wider scope of people, the more the issues regarding privacy are brought to attention. Sensors and computing systems enable robots to detect people’s expressions and interact with proper response. For example, when teaching children with autism, the robot can sense and capture children’s emotions by using its sensors and cameras. Although this seems legitimate and even beneficial to therapy, robotic technology, in fact, has a dark side. If information detected by the robot is categorized and recorded, it violates the right to personal privacy. Also, this raises many other concerns “about what information should be stored, and who is permitted to access to it” (Sharkey, 2016). Therapists use social robots as an assistive character might have access to the information for the purpose of tracking the therapy progress and reporting to patients’ families. Yet, this cannot be absolutely problem-free, and it might be even worse if the information is transferred into someone’s hand and misused.

With regards to invasion of privacy, there are many other problems to consider. A major one is that if social robots are given the power to record and store personal information, to what extent and what kind they should be allowed. When a robot uses its sensors to function and perform its work, there is possibility of involving in more intimate information. With physiological measures and emotional facial expressions recognition, robots are able to detect and analyze the emotional state of patients. Also, it is discussed that whether a robot can be authorized to assess the mental capacity of patients (Simpson, 2016). Essentially, all the information of physiology, emotion and mental is extremely intimate and personal that most people would like to keep if from being known.

_Future Implications_

Since the original investigation with the Aurora project in 1998 (Dautenhahn, 1999), the concept of social robots as a therapy tool for people on the autism spectrum has spread to many other research groups and universities (Ricks & Colton, 2010). As with most technologies when they are first introduced, there is room for improvement and there are some concerns moving forward.
Although the future is uncertain, robotherapy, especially for children with autism, looks promising.

One of the features many researchers hope to see in future designs is self-operation. Currently, most robots have to operate in conjunction with either a parent, teacher, or therapist in the room (Dautenhahn, 2003b). However, there is progress being made with inventions like transitional wearable companions that look more like a stuffed animal and are used with bracelets that monitor physical attributes of the patient (Özcan, 2016). Although researchers are adamant that the robots should never replace the role of human interaction in therapy, self-operating features reduce possible interference or distractions from therapy sessions (Dautenhahn, 2003a). It also allows for therapy to exist on a more consistent basis and in environments beyond the lab (Dautenhahn, 2003b). This is crucial for the therapy’s success, since the main goal is integration into society, generalizing the “rules” learned to unpredictable situations (Dautenhahn, 2003b; Ricks & Colton, 2010).

Future designs are also hoped to keep an interaction history that creates specific patient profiles and therapy regimens (Dautenhahn, 2003b), constantly revised by the collection of real-time data (Cabibihan, Javed, Ang, & Aljunied, 2013). The robot would facilitate different learning games or act differently depending on where the patient falls on the autism spectrum. It would also record how they respond to behaviors and therapy techniques, adjusting for future interactions accordingly (Dautenhahn, 2003b).

As for future implications in the nontechnical design, the main debate is how realistic to make the robot. If the robot is too realistic, it is feared that the patient will get attached to it, choosing to only interact with the it instead of generalizing what they learned from their therapy sessions to social interactions (Groopman, 2009). However, this anthropomorphism can have positive effects as well. Bonding with the robot has been shown to maintain interest in the robot, therefore increasing the amount of therapy they are exposed to (Yee, et al., 2012). In contrast, a more machine-like robot is more approachable for someone with autism, but may not be as effective in inducing generalization later on (Lee, Takehashi, Nagai, Obinata, & Stefanov, 2012; Ricks & Colton, 2010). A series of robots or a robot with interchangeable facial features has been suggested as a solution to this (Giullian, et al., 2010; Ricks & Colton, 2010). As the patient improves, the robot would become more humanoid.

Although increased intrigue through the 2000s on this topic has sparked a multitude of studies and standardization of the technology, there is still work to be done. As of date, no longitudinal studies have been done (Cabibihan, Javed, Ang, & Aljunied, 2013). Longitudinal studies are essential for any claims to be made on the effectiveness of this therapy technique in the long term. The studies that have been conducted should be repeated to add validity to existing
findings (Cabibihan, Javed, Ang, & Aljunied, 2013). There are a few requirements for social robots designs when built for their use in the therapy of children with autism (Giullian, et al., 2010), but more focus needs to be put on this topic. Laws should be put in place to determine the ethical responsibility if negative consequences from robotherapy arise (Groopman, 2009).

Considering the rate at which interest in therapeutic robots has persisted, it is fair to say social robots are likely to stay. They may become a common part of our society, especially for children on the autism spectrum. Some predict these robots will serve as a “cognitive orthotic”, tagging along with the children in their everyday life. Even though they would often be nonoperational, they would help facilitate social interaction just by their presence, serving a similar purpose as a security blanket (Ricks & Colton, 2010). Others have imagined a specific ASD therapy robot would not exist. Instead, the functionality of these robots would be integrated in a multifunctional robot that would serve the whole family (Dautenhahn, 2003b).

Conclusion

Overall therapeutic robots are constantly being advanced to help children with autism as well as people with other needs. The development of social and therapeutic robots has progressed far from the initial automated dancing robot and now they are being imbedded with human intelligence to bring humans comfort. Milo in particular has been able to do this for many autistic children and is constantly being updated to improve its abilities. The advanced technology utilized in Milo sets him apart from other social robots in the field through the use of cameras, sensors, and motors to allow maximum interaction. His speed of voice and ability to continually repeat lessons assist children with autism to learn at their own rate. Children who may have trouble with therapists are found to be more engaged with Milo through his whimsical interactions that appeal to young children. Though there are many conflicting emotions and ideals about the humanistic, personal, and privacy parts of Milo, the future for the advancement of Milo and other robots will continue to grow and influence individuals with autism and other disabilities.