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## Using Innovative Technologies as Therapeutic and Educational Tools for Children with Autism Spectrum Disorder

Patrice L. (Tamar) Weiss, Eynat Gal

**Key words:** Autism spectrum disorder, technology, virtual reality, shared active surfaces, therapy, education

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### Abstract

During the last decade, researchers and clinicians have noted the value of technology, in general, and computer-based activities, specifically, as therapeutic and educational tools for people with Autism Spectrum Disorder (ASD). In recent years, a growing number of innovative technological applications have been developed with the aim of helping people with ASD improve social and communication skills, enhance emotional expression, learn vocabulary and functional daily activities. Computer-based technologies appear to be beneficial for people with ASD due to their capacity to reduce distractions from extraneous sensory stimuli, to deliver consistent and predictable responses and to provide clearly defined tasks. The objective of this paper is to help the reader learn about the attributes and limitations of four technologies (videomodeling, shared active surfaces, virtual reality and robotics) in order to determine which of them may be considered for immediate use, and which will become useful only at a later date.

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## Introduction

Autism spectrum disorders (ASD) are defined as pervasive developmental disorders that involve deficits in social relationships, communication impairments, repetitive behaviors and restricted interests (Bailey, Phillips, & Rutter, 1996). Children with ASD make or accept fewer social initiations and spend more time playing alone compared to their peers (Koegel, Koegel, Frea, & Fredeen, 2001). These children typically exhibit severe attention (Courchesne et al., 1994; Pierce, Glad, & Schreibman, 1997) and language (Rutter, 1978) deficits as well as difficulties in tasks requiring social (Pierce & Schreibman, 1995), affective (Hobson, Ouston, & Lee, 1988) and motivational (Schreibman, 1988) competencies. These formidable obstacles challenge the education of children with ASD.

During the last decade, researchers and clinicians have noted the value of technology, in general, and computer-based activities, specifically, as therapeutic and educational tools for people with ASD (Grynszpan, Martin, & Nadel, 2005). In recent years, a growing number of innovative technological applications have been developed with the aim of helping people with ASD improve their social and communication skills. Technological applications have been developed to enhance emotional expression (Silver & Oakes, 2001), to learn vocabulary (Moore & Calvert, 2000), and to improve social problem solving (Bernard-Opitz et al., 2001) and functional daily activities (Josman et al., 2008). The technologies include learning activities based on multimodal computer interfaces (Bernard-Opitz et al., 2001; Bosseler & Massaro, 2003), videomodeling (Dowrick, 1999), virtual reality (Parsons, Leonard, & Mitchell, 2006; SikLanyi & Tilingier, 2004), robotics (Dautenhahn, 1999) and shared active surfaces (Gal et al., 2005, 2009).

Clinical observations suggest that children with ASD are highly motivated by computer-based tasks (Hart, 2005). Moore (1998) and Murray (1997) indicated several reasons for the special interest that children with ASD have in computer-based learning, and its advantages for the core deficits. First, focusing on a computer screen, where only necessary information is provided, may help people with ASD reduce distractions from extraneous sensory stimuli. Second, computers are free from social demands and can provide consistent and predictable responses; this can be particularly useful for people, such as those with ASD, who often find the surrounding environment confusing and unpredictable. Third, the safety of a clearly defined task, and the usually specific focus of attention appears to help people with ASD concentrate

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Using Innovative Technologies as Therapeutic and Educational Tools for Children  
with Autism Spectrum Disorder

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on this activity (Murray, 1997). All these characteristics make computer-based interventions beneficial for people with ASD, who usually demonstrate increased responsiveness to environmental stimuli when events are more predictable (Ferrara & Hill, 1980). In contrast, the responses from some professionals and parents to technology have been mixed due to the fear of increased social withdrawal (Bernard-Opitz, Ross, & Tutas, 1990; Panyan, 1984).

There is a lack of information in the literature regarding the frequency and types of technology used within the educational system. A local survey of ten teachers who work with children with ASD, reported that computers are used mainly for internet browsing, educational software, word processing, and games.

Some of the teachers were acquainted with technologies, such as virtual reality, but had rarely used them. In contrast, the literature reports on a broader range of technologies for therapeutic and educational work with children with ASD that are not currently in use in the educational system in Israel (Neale, Kerr, Cobb, & Leonard, 2002; Wert & Neisworth, 2003).

This paper reviews studies that described and assessed technological applications for ASD. The paper does not provide an exhaustive review of the available technologies; rather, our objective was to discuss a selected sample of technologies to illustrate how they may be used to enhance social interaction in those with ASD. It specifically focuses on video modeling, shared active surfaces, virtual reality and robotics. The objective is to help the reader learn about the attributes and limitations of each technology in order to determine which of them may be considered for immediate use and which will become useful only at a later date.

### *Video modeling*

Modeling is a procedure that has received much attention in the literature, as an intervention tool for enhancing language, and affective and social skills. The concept of modeling or observational learning as an intervention technique was introduced over 40 years ago by Bandura and Menlove (1968), who suggested that it has a profound impact on the development of children. Specifically, they noted the tendency of children to observe others in order to acquire new skills, rather than basing skill acquisition on personal experiences.

Technological advances during the past two decades have allowed

researchers to extend the concept of modeling to include the use of video to teach a wide variety of skills. Video modeling entails demonstration of desired behaviors through video representations of the behavior. A video modeling intervention typically involves an individual watching a video demonstration and then imitating the behavior of the model. It can be used with peers, siblings or adults who model the desired behaviors.

Another approach to video modeling is video self-modeling (VSM), which incorporates the "self" as the videotaped model, allowing individuals to imitate targeted behaviors by observing themselves successfully performing an adaptive behavior (Dowrick, 1999). VSM interventions typically fall within one of two categories: (a) positive self-review (PSR), and (b) video feed-forward (Dowrick, 1999). In PSR an individual watches him or herself successfully engaging in a low frequency behavior or activity that is currently in his/her behavioral repertoire. In video feed-forward an individual observes him or herself successfully demonstrating skills that are slightly above his/her current capability, using "hidden support" such as adult hints that are edited out of the final version of the video (Bellini & Akullian, 2007).

Video modeling and video self-modeling have been used across multiple disciplines and populations to teach a wide variety of skills, including motor behaviors, social skills, communication, self-monitoring, functional skills, vocational skills, athletic performance, and emotional regulation (Bellini & Akullian, 2007). They are viewed as techniques that can potentially be effective and efficient for teaching children with ASD a number of different behaviors and skills, and specifically, they have been used with children with ASD to enhance social interaction, communication, functional skills, and play behaviors (Buggy, Toombs, Gardner, & Cervetti, 1999; MacDonald, Clark, Garrigan, & Vangala, 2005; Wert & Neisworth, 2003).

The results of a number of studies suggest the utility of video modeling and VSM in promoting conversation skills. Wert and Neisworth (2003) examined the effectiveness of VSM in teaching young children with ASD to make spontaneous verbal requests in school settings. VSM interventions led to substantial increases in spontaneous verbal requests in the four children who participated in the study. Buggy, Toombs, Gardner and Cervetti (1999) examined the effects of VSM on the acquisition and maintenance of play-related verbal responses in school-aged children with ASD. Participants showed a marked increase in verbal responses after the introduction of the VSM intervention; however minimal maintenance effects were observed. Charlop and Milstein (1989) examined the maintenance and generalization

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effects of a video modeling intervention on the conversation skills of children with ASD. Results suggested that the video modeling procedure was effective in teaching conversation skills to these children; the effect continued beyond the generalization and appeared to generalize to other activities. Moreover, video modeling led to a faster acquisition of these skills (Charlop-Christy et al., 2000).

Many of the studies focused on the enhancement of behaviors that are related to the children's social communication skills. Nikopoulos and Keenan (2004) examined the effects of a video modeling intervention on social initiation and play behaviors in three children with ASD. Each child watched a videotape showing a typically developing peer and the experimenter engaged in a simple social interactive play session using a single toy. For all children, social initiation and reciprocal play skills were enhanced, and these effects were maintained at 1- and 3- month follow-up periods.

D'Ateno, Magiapanello, and Taylor (2003), and MacDonald, Clark, Garrigan, and Vangala (2005) examined the effects of video modeling intervention in teaching play behaviors to preschool children with ASD. Participants watched adult models act out scripted sequences of pretend play. The procedure led to rapid acquisition of both scripted verbal statements and scripted motor actions for all play sequences. However, the interventions did not generalize to unscripted play behaviors. Egel et al. (1981) taught children with ASD various discrimination tasks (e.g., color, shape, on/under, and yes/no discrimination) by having them observe video modeling of typically developing children correctly perform such tasks.

Video modeling was also been used to enhance perspective taking for children with ASD. This refers to the ability to understand the mental states of others in order to explain or predict behavior (Charlop-Christy, & Daneshvar, 2003).

To summarize, video modeling and video self-modeling have shown themselves to be effective intervention strategies for addressing social-communication skills, and functional skills for children and adolescents with ASD. Skills acquired by video modeling and VSM were maintained over time and generalised across persons and settings. Due to its effectiveness and accessibility, this tool is widely used in various ways in educational settings.

### *Shared Active Surfaces*

The term Shared Active Surfaces (SAS) describes devices that are specifically designed to allow simultaneous interaction by multiple users on the same interface. Generally, this kind of technology is characterized by large displays that can be placed in horizontal (also called 'tabletop' devices) or vertical (also called 'wall displays') positions. SAS represent a shift from the one-user-one-computer paradigm, and therefore, researchers have focused on the benefits provided by SAS in supporting collaborative activities.

An important benefit offered by SAS is the direct manipulation of digital objects through touch. This interaction modality reduces the barrier between the user and the interface, in comparison to the more traditional mouse and keyboard interfaces. Direct manipulation becomes particularly useful for children who may have difficulties in their motor coordination ability (Piper et al., 2006). One further advantage of these devices is that they are large enough to allow multiple users to collaborate without crowding, in contrast to computer monitors, which are usually not big enough to allow shared observation and interaction by more than one or two persons. These features, together with well-designed activities, seem to suggest that SAS is an ideal tool to enhance social skills in children.

A few studies have investigated the potential benefit of shared active surfaces for children with ASD, specifically focusing at enhancing social interaction. Some of these applications are co-located interfaces on a tabletop device that include sets of rules to help participants structure the interaction, making collaboration more effective. Tabletop interfaces have demonstrated their effectiveness as a means for involving pairs of children with ASD in computer-based activities, where social skills training was the major target (Gal et al., 2005, 2009). Piper et al. (2006) described an application that can be used by groups of four children with Asperger's syndrome. The system included a computer-enforced turn-taking mechanism, forcing the participants to vote unanimously in order to proceed with the game.

In the studies conducted by Gal et al. (2005, 2009), pairs of children with high functioning ASD were involved in the collaborative narration of a story using an application called a "StoryTable". The StoryTable was implemented using the capabilities of the MERL's DiamondTouch (DT) Table (Dietz & Leigh, 2001). The DT is multimodal in character, providing visual stimuli, responding to touch commands, and supporting single or multiple users, including successive actions such as simultaneous touch commands and multi-user drag-and-drop acts. Each user sits or stands on a receiver (a thin pad),

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such that touching the table surface activates the surface. The StoryTable provides virtual environments, where users can manipulate objects and characters within the context of a specific story background. It enables the production and recording of joint narratives, and requires joint touch of the icons in various stages of the story telling. These joint touches are referred to as "enforced collaboration", that is, a computer-supported interaction paradigm, wherein participants are required to carry out joint actions on digital objects during a common activity (Cappelletti et al., 2004). Enforced collaboration was found to be effective in various interaction contexts such as collaborative storytelling among primary school children (Zancanaro et al., 2007).

The same software, when used with children with ASD, had a positive effect on social interaction among children with high functioning ASD (Gal et al., 2005, 2009). The participants were more likely to initiate positive social interaction with peers after the intervention. The level of shared play of the children increased from the pre-test to the post-test, and they all increased their level of collaboration following the intervention. Finally, the children with ASD demonstrated lower frequencies of autistic behaviors while using the StoryTable in comparison to the free construction game activity.

Another program that is based on an enforced collaboration paradigm is the Collaborative Puzzle Game (CPG), which does not rely on narrative skills but rather on visuo-spatial abilities. In this program, children jointly select and drag single puzzle pieces, in order to collaborate complete a puzzle (Battocchi et al., 2008, 2010). The digital puzzle pieces can be dragged over the surface by direct finger touch simultaneously by two players and the interaction is enriched with visual and auditory feedbacks. Results of the CPG studies indicated that enforced collaboration is associated with a positive effect on collaboration, which is reflected by increased rate of simultaneous activity by the two players (Battocchi et al., 2010). More recently, the enforced collaboration paradigm has been combined with Cognitive Behavioral Therapy as an intervention technique for enhancing social cooperation of children with high functioning ASD (Giusti, Zancanaro, Gal, & Weiss, 2011).

These studies give preliminary evidence of the potential benefit of SAS technology. From these results, we can foresee the potential benefit of using the SAS with children with ASD, in particular in training and rehabilitation programs in which collaborative behaviors and social skills, such as shared attention for objects, and negotiation and imitative behaviours, are the main focus. However, to date, multi-touch tables are relatively large and expensive and not yet supported by a library of off-the-shelf software. Work is currently underway to implement the enforced collaboration paradigm on regular touch



screens or to have them operate via two or more synchronized pointing devices.

### *Virtual reality*

Virtual reality (VR) may be defined as the use of interactive simulations created with computer hardware and software to present users with opportunities to perform in virtual environments (VEs) that appear, sound and, occasionally, feel similar to real world objects and events (Sheridan, 1992; Rizzo, Buckwalter, & Neumann, 1997; Weiss & Jessel, 1998). The effectiveness of VR in rehabilitation is based on a number of unique attributes of this technology, including the use of ecologically-valid experiential tasks that are motivating, challenging, yet safe (Rizzo, Buckwalter, & Van der Zaag, 2002; Schultheis & Rizzo, 2001). Importantly, the automated nature of stimulus delivery within VEs enables a therapist to focus on the clients' performance, to observe whether they are using effective strategies, and to document all results. Clinicians use VR to achieve a variety of therapeutic objectives by varying task complexity, type and amount of feedback, and the extent of independent activity. All of these attributes have been noted to be of particular relevance for people with ASD (Parsons & Cobb, in press; Strickland, Marcus, Mesibov, & Hogan, 1996; Trepagnier, 1999).

In a pioneering study, Strickland et al. (1996) used a desktop virtual environment viewed while wearing a head-mounted display (HMD), to teach two children with ASD, aged 7.5 and 9 years, to cross a street. She found that both participants succeeded in adjusting to the HMD (which was much heavier than those currently used) and in concentrating on the task. They both learned to navigate within the virtual environment, and to locate and approach objects that moved. Only one of the two learned to stop when he reached the object, which constituted the goal of this task. Although the initial results were encouraging, the implications of the study are limited due to the small number of participants and concerns related to the use of an HMD with this population.

Cobb et al. (2002) used a computer desktop system to explore the suitability of a virtual coffee house to support the learning of social communication skills for teenagers with Asperger's syndrome. The rationale behind this study was that, if social scenarios could realistically be replicated within virtual environments, the limited personal interaction afforded by the computer interface would be inherently more attractive to these youth, and therefore, provide a safe and supportive environment for learning (Parsons et

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Using Innovative Technologies as Therapeutic and Educational Tools for Children  
with Autism Spectrum Disorder

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al., 2000). The environments that were chosen represented typical social situations that would be familiar to most users with the objective of supporting social interaction behavior specific to two tasks: lining up to enter a coffee house and finding somewhere to sit. This required users to control the movement of their avatar (virtual person whose actions represent those of the user) in the virtual coffee house, to respond appropriately to other avatars, and to make decisions about when they should communicate with others and what they should say. Observations of how educators used the virtual environment to support teaching of these specific skills in the classroom showed that they used the virtual environment as a visual prompt to promote discussion about what happened in the social scenario and why characters behaved as they did (Neale et al., 2002).

Teachers reported that the virtual environment helped students discuss their anxieties in dealing with these situations (Neale et al., 2002). Examinations of the navigation patterns of participants in the virtual coffee house, documenting how much time they spent at specific locations (e.g., near or far from virtual people) and whether their behavior was appropriate (e.g., did they sit at a free table in the cafe? or one that was already occupied), showed that people with ASD knew how to respond to the virtual setting in a non-literal manner, attributing to the avatars 'people-like' behavior (Parsons, 2001). Moreover, the virtual environments were used and understood appropriately by young people with ASD and were effective in supporting learning about social skills (Parsons et al., 2004, 2005, 2006; Mitchell et al., 2007).

Another street crossing environment was used by children and youth with ASD to examine whether they were able to learn street-crossing skills with the aid of the simple, desktop environment (not an HMD), and whether the simulation helped them to improve their pedestrian behavior in a real road street-crossing setting (Josman et al., 2008). The findings demonstrated that the research and control groups differed in their initial ability to succeed in the VE, but no significant differences were found between groups in measures related to pedestrian behavior (e.g., number of times looked to the left and right). This finding is similar to that of Parsons et al. (2004, 2005), who found no differences between youth with ASD and youth who are typically developing on all measures in their virtual pedestrian and coffee shop simulations.

Cassell (2004) and colleagues (Cassell & Bickmore, 2003; Ryokai, Vaucelle, & Cassell, 2003) developed the novel "Virtual Peer", a life-sized, animated character that resembles the children with whom it interacts. Virtual peers appear to give children with ASD opportunities to repeatedly rehearse

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both verbal and nonverbal interaction skills. They also appear to empower children, offering the ability to be manipulated by their users, and to encourage the creation and practice of dialog and sharing behaviors.

Although the research support is mainly from studies with small numbers of subjects, there is a consensus that VR appears to be an effective way to improve the social abilities of children with ASD and to give them opportunities to learn skills that transfer to daily life abilities (Parsons & Cobb, in press). The simpler virtual environments may be run on inexpensive computers; however, there is still a lack of widely available software for clinical and educational use.

### *Robotics*

A robot is an electro-mechanical device that uses microprocessor technology and information received from one or more sensors to manipulate objects within its immediate environment (Preising, Hsia, & Mittelstadt, 1991). In order to create a device that is readily comprehended by users their appearance, design and function is often based on a human model (humanoid). Robots in rehabilitation are used as prosthetic or orthotic devices to replace or assist function, as a therapeutic intervention to augment and facilitate exercise, or to provide social assistance that serves to motivate, encourage and monitor social interactions or exercise. The latter option is the one used for ASD.

To date the literature on applications of robotics for ASD is not extensive, and these have typically aimed at motivating and monitoring play and social interactions. Weir and Emanuel (1976) reported the use of a primitive LOGO robot learning environment to promote positive communication in a young child with ASD. This robot was not autonomous and the child did not physically interact with it. Two early interactive robotic systems, KISMET (Breazeal, 2003) and the ROBOTA dolls (Billard, 2003) were both humanoid in design, being able to generate expressive social interactions with others. Their purpose was to encourage the development of social relationships between a robot and a human via imitation, speech and gestures. Work by Robins, Dautenhahn, teBoekhorst, and Billard (2005) focused on studying the way children with ASD play with robots. This longitudinal study demonstrated that children responded positively to robots when exposed over a number of therapeutic play sessions. However, no adaptive technology was used; the robots were built and programmed to interact in fixed, completely predictable

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ways. Scassellati (2005) investigated the use of robots for diagnosis and treatment of ASD. He focused on the use of a non-sensing robot, which could execute scripted actions, but could not sense nor respond dynamically to the individuals. He concluded that there is much potential in the use of robotics with this population because the robots engage these children very easily.

Robots as interactive playmates for children with ASD have also been developed (e.g., Montemayor et al., 2000). The AURORA robot was a major step forward in using a non-humanoid, autonomous mobile robot to encourage children with ASD to become more engaged in interactions known to be important in human social behavior (e.g., eye-contact, joint-attention, imitation) (Dautenhahn, 1999). Children were encouraged to interact with the robot in whatever position and manner they preferred (e.g., lying on the floor or standing; touching or watching from a distance). The AURORA robot is deliberately non-humanoid robot in an effort to avoid the difficulty that children with ASD have in interpreting facial expressions and other social cues in social interactions. This robot aims to provide highly predictive motor and social responses. Initial results using the AURORA robot showed that most children responded positively and had great interest in interacting with it. A comparative study of the AURORA robot with a passive, non-robotic toy demonstrated that the children had more interest in interactions with the robot than with the inanimate toy (Werry & Dautenhahn, 2007). Moreover, the children showed less autistic and repetitive behavior when playing with the robot.

Feil-Sefer and Mataric (2008) designed the Behavior-Based Behavior Intervention Architecture (B3IA) as an autonomous robot capable of sensing the actions of children and understanding their approximate meaning in a given social context, of acting autonomously within specific interaction scenarios, and of reacting to both the immediately sensed situation and to the interplay of interaction over time. The B3IA robot observes the behavior of the child via sensors in the environment and/or worn by the child. The researchers suggested that a child who interacts with a contingent robot (one that responds explicitly to his behavior) will exhibit more positive social behavior than when interacting with a robot that responds randomly. For example, when the child pushes one button, the contingent robot blows bubbles while turning in place. When the child does not push one of the buttons, the robot does nothing. Sensors on the child enable the robot to respond in a truly contingent manner.

Although the use of socially assistive robots appears to have much promise for children with ASD, the technology, to date, is expensive. Since the robots are customized units used in specific research studies, it will likely take

another 5 years before they are available to the community at large.

Discussion

The literature indicates a great potential for wider clinical and educational use of various technologies for children with ASD. It provides support for the suitability of technologies, such as video modelling, SAS, VR and robotics to achieve various therapeutic and educational goals. The main objectives currently addressed by these technologies include those related to social, communication, emotional, play, and daily activity skills.

As reviewed above and summarized in Table 1, the various technologies differ in the extent of the evidence accumulated to demonstrate their ability to help children with ASD improve in the targeted skills. A 3- point scale is used in Table 1, where three stars indicate that the technology has been shown to have considerable potential down to a single star, indicating a paucity of evidence. Video modelling is currently considered to be the strongest of the

Table 1.  
Potential to achieve therapeutic/educational goals through video modeling, shared active surfaces, virtual reality and robotics.

	Video modeling	Shared Active Surfaces	Virtual Reality	Robotics
Social skills	***	***	***	*
Communication	**	*	**	*
Emotional skills	***	*	*	*
Play skills	***	**	**	**
Functional activities	*	*	***	*

Note. A three point scale is used, such that three stars indicate that the technology has been shown to have considerable potential, whereas a single star indicates a paucity of evidence.

Using Innovative Technologies as Therapeutic and Educational Tools for Children  
with Autism Spectrum Disorder

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available technologies in terms of evidence. Research has demonstrated its strong potential in the areas of communication, social and emotional skills, but there is less evidence for its abilities with respect to communication and functional activities. SAS is a relatively new area of research and has mainly focused on applications of social skills, for which it has been shown to have great potential. Virtual reality has, to date, mainly addressed social skills and functional activities (e.g., street crossing) and, to a lesser extent, communication and play skills. Although robotic technologies have been available for decades, their use for children with ASD is relatively recent, and is still at an initial stage of development for clinical aims.

Parents and educators have expressed various concerns regarding the use of technology for those with ASD (Moore, McGrath, & Thorpe, 2000). One such major concern addresses the fear that technology may further increase the social withdrawal of children, who are prone to social isolation to start with. In an effort to alleviate this concern, most technologies are used with two or more children at the same time, which may be an asset to a teacher who often needs educational tools that meet the needs of larger groups.

Researchers and clinicians have also identified various advantages that technology provides for children with ASD, who appear to be nurtured by technology-oriented learning, and have shown improvements in many of the ASD core symptoms following technology-based interventions (Dautenhahn & Weery, 2004; Gal et al., 2009). Nevertheless, although the literature indicates many advantages of using technology for children with ASD, technology has, to date, addressed only some of the key clinical challenges. This review has shown that the main applications of technology are in social interactions, play and language skills, and only a few applications address emotional issues, and daily activity skills.

Moreover, despite advances in research, clinical observation and surveys reveal that only the most basic types of technology, such as simple educational software, the internet and videotaping, are currently in use in educational settings (Shields & Behrman, 2000). In contrast, VR, SAS, video modeling and robotics, are used less frequently. Teachers who work with children with ASD are often not even aware of the potential of such technologies as educational tools, and do not have the financial or technical resources to adopt them.

This gap between the potential of technological applications and their actual use can be attributed to a number of practical limitations. First, the devices are often not available to teachers, clinicians and parents, due to their relatively high cost and need for technical support. Moreover, many are

currently available only as research prototypes that need further development prior to adoption for everyday use. These devices, in particular, are often complex to operate, since they have not yet been designed and implemented with the end user in mind.

To summarize, although the literature abounds with studies regarding the benefits of the use of technology for those with ASD, parents and clinicians remain at a loss regarding the feasibility, viability and effectiveness of technological devices. Indeed, there is an urgent need to bridge the gap between developing technological innovations and their actual use for children and adolescents with ASD, making technology more accessible for the potential use with ASD, and bringing it, when appropriate, closer to each child's individualized intervention program. In addition, such programs should provide specific guidelines to teachers as social mediators, to enable them to address the type and level of facilitation, and environmental arrangement that will enhance the advantages of the technology, but minimize its disadvantages, such as social withdrawal and perseveration. Future research, development and marketing must address these highly important goals.

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Using Innovative Technologies as Therapeutic and Educational Tools for Children  
with Autism Spectrum Disorder

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