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## A Review of Training Interventions to Teach Safety Skills to Children with Autism

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A Review of Training Interventions to Teach Safety Skills to Children with Autism

by

Gabrielle Mondello

A thesis submitted in partial fulfillment  
of the requirements for the degree of  
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model

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## **Abstract**

Teaching safety skills to children with autism is a serious responsibility for caregivers, siblings, teachers, and other important people in the children's lives. Finding the effective and most efficient way to teach these skills is important. Behavioral skills training (BST), in situ training (IST), video modeling, virtual reality, and the use of simulation training have all been evaluated for teaching safety skills. This paper discusses the safety threats faced by children with autism and reviews these various approaches to teaching safety skills.

## Introduction

As human beings age and progress through childhood, their independence increases, which results in a decrease in their parental and caregiver supervision. As supervision is provided less, the chances of children encountering unsafe situations heightens, and the need for safety skills is imperative. Safety skills are crucial for children to have in their repertoire. For example, being able to recognize and safely respond to an unauthorized or unknown adult, knowing how to respond safely in a fire, understanding what to do when there is a lure for inappropriate sexual abuse, remembering not to touch poisonous substances, having the ability to read and follow crosswalk signs, and knowing the safe steps to take when a firearm is in view are all skills that can prevent injury and death (Batu et al., 2004; Haseltine & Miltenberger, 1990; King & Miltenberger, 2017, Morgan & Miltenberger, 2017). Although the complexity and importance of safety skills vary, researchers have conducted numerous studies to determine the best way to teach these skills to neurotypical children and children with autism (Dixon et al., 2010; Mechling, 2008; Miltenberger et al., 2020).

Although abduction by strangers is rare, it does still occur and is a significant concern to parents all over the United States. In fact, between 2000 and 2007, the Federal Bureau of Investigation reported having over 2,000 investigations involving child abductions (The Federal Bureau of Investigation, 2009). Many parents have turned to never leaving their kids unattended or telling their kids simple rules such as “never accept candy from a stranger” to

prevent abductions (Children’s Hospital of Philadelphia, 2018). In contrast, schools have turned to the use of school uniforms and adding more metal detectors to campuses (Tolan, 2000). Unfortunately, in most cases, these strategies are deemed ineffective (Tolan, 2000), and more action is needed.

In 2008, 405 children ages 0 to 14 years old died in residential fires, and it is reported that around 40,000 children under the age of 14 are seriously injured by residential fires, yearly (U.S. Fire Administration, 2019). Responding to fire alarms is taught at a young age; however, as statistics show, sometimes fire alarms do not always evoke the correct behavior. More research is needed to teach children to respond safely in fire situations.

The sexual abuse of individuals with intellectual and developmental disabilities is a prominent issue. However, teaching these individuals how to say no, get away safely, and tell a trusted adult is not as well-known (e.g., Lumley & Miltenberger, 1997). In fact, there is very little research focusing on teaching these safety skills to individuals diagnosed with a disability (Egemo-Helm et al., 2007; Lumley et al., 1998; Miltenberger et al., 1999; Spivey & Mechling, 2016). Nonetheless, children who have been diagnosed with disabilities are at higher risk for child sexual abuse than “neurotypical” children. In 2010, the Administration on Children Youth and Families report, stated that around three million reports of child abuse were made in the last year and 10 percent of these cases involved sexual abuse. Of these cases, 11 percent of victims were reported having an intellectual or developmental disability (Smith & Harrell, 2013).

Furthermore, every day in the United States, over 300 children ages 0 to 19 are rushed to an emergency department because of accidental poisoning, and of these daily emergency

admissions, around two of these children end up dying (Centers for Disease Control and Prevention, 2019). These accidental poisonings are due to items around the house, such as cleaning products, medications, and more. Unintentional poisoning is the second most prevalent cause of accidental injury death in the United States behind car crashes (Centers for Disease Control and Prevention, 2019). More studies in the future should focus on how to effectively teach children not to consume these everyday products found in households and how to report to an adult when these poisonous products are in sight.

Children are taken to, or wander into, environments where traffic is present, whether it be neighborhoods or walking across a busy road. According to the US Department of Transportation, in 2014, about 4,280 pedestrians were killed in traffic-related crashes. An additional 70,000 were seriously injured in the United States (Department of Transportation, National Highway Traffic Safety Administration, 2012). This safety threat may be even more significant for those who are diagnosed with autism because of their possible elopement behaviors and their lessened ability to be aware of their surroundings (Centers for Disease Control and Prevention, 2019).

Firearm accidents happen daily across the United States. The majority of people killed or injured in these accidents are those under the age of 24, and the person shooting the gun is usually the victim or the same age as the victim and either closely related or a friend (Hemenway et al., 2010). Furthermore, when children find guns, they often play with them which can cause injury to themselves or others (Jackman et al., 2001). Therefore, children and even young adults need to be trained on what to do when they find a firearm and a caregiver is not present. Many homes have a firearm, but sometimes this firearm gets unattended and

accessible to children. For this reason, it is imperative for children to know how to safely react to the presence of a gun when no one else is around.

Research shows that individuals with autism sometimes elope from adult supervision and even safe environments, which has been a known contributor to injury and death. Studies have found that children are most likely to elope from their home, local stores, and classrooms or schools (Anderson et al., 2012). Teaching children with autism safety skills can be challenging because of learning, social, and communication deficits. Individuals with autism are not always aware of their surroundings and do not always pick up on all of the details or cues in social situations as quickly as the “neurotypical” individual would. Therefore, this makes them more susceptible to risky situations.

Numerous studies have focused on different training interventions to teach safety skills to neurotypical children and children diagnosed with autism. A large amount of the research focused specifically on the effectiveness of behavioral skills training (BST) and in situ training (IST) (Johnson et al., 2005, 2006, Miltenberger et al., 2020). Although these might be the most researched ways to teach skills, other studies have evaluated training interventions including video modeling, virtual reality, and simulation training (e.g., Batu et al., 2004; Godish et al., 2017; Goldsmith, 2008). All five of these training interventions have proven to be effective in varying degrees in teaching a variety of safety skills across different populations and in different settings. Additionally, each of these training interventions has various benefits and limitations associated with them. Although BST, in situ training, video modeling, virtual reality, and simulation training are all different forms of training, they all strive to reach the same goal, to teach essential safety skills that will help ensure the safety of those children learning them.



Therefore, the purpose of this paper is to discuss the safety threats faced by children with autism and examine the effectiveness these five training interventions to teach safety skills to children with autism.

## **Training Interventions**

### **Behavioral Skills Training**

Behavioral Skills Training (BST) is a training package that uses instruction, modeling, rehearsal, and feedback (praise or further instruction) to teach a new skill. Instruction is when a description of the new skill is provided to the participant. The skill's importance is addressed and how and when to use the skill is explained. The instructor uses this step as a time to explain to the participant how each target behaviors should look and in what circumstances it is needed. Instruction can be repeated if necessary. After instruction, the individual who is implementing the training models the safety skill. Modeling is done when the instructor physically demonstrates how the target behaviors should look. Once the researcher models the skill, it is the participant's turn to rehearse the skill as the researcher presents a simulated safety threat. Finally, during feedback, the instructor comments on the participant's responses after the participant has rehearsed each target behavior. Feedback can be given in the form of praise for correct responding and/or further instruction for errors. Additionally, it is common for this type of training to be done with a predetermined criterion for success such as correct performance across three role-plays (Miltenberger et al., 2020).

BST has been shown to be an effective training technique to teach children diagnosed with disabilities a wide variety of important skills, including safety skills (e.g., Ledbetter-Cho et

al., 2016; 2017; Sanchez & Miltenberger, 2015; Summers et al., 2011). For example, in 2016, Ledbetter-Cho et al. evaluated BST to teach abduction prevention skills to four boys diagnosed with autism. In this study, BST sessions were conducted individually and in a clinic setting. During these BST sessions, the therapists explained why abduction skills are important and told the participant the steps to take when a stranger approaches them. The therapist then asked the participant to state the steps they had just gone over. After the participant was able to complete this step, the therapist played a short video demonstrating all the target behaviors. Following the video, the participant was told it was time to practice these target behaviors seen in the video in a new location where a confederate stated an abduction lure. If the participant said no, ran away, and told an adult after the lure was stated, praise was given. If the participant failed to complete any of these three steps, the therapist provided corrective feedback. The results of this study showed that BST can be an effective training to teach abduction prevention skills to children with autism. However, BST is not always effective. For example, Sanchez and Miltenberger (2015), found that adolescents with disabilities did not exhibit the abduction prevention skills after receiving BST. Further in situ training was needed for these individuals. Other researchers have found similar results when teaching safety skills to typically developing children (Himle et al., 2004; Jostad et al., 2008; Miltenberger et al., 2004).

Behavioral Skills Training was created to not only promote the learning of new skills but also to enhance the generalization of the skills to the natural environment (e.g., Jostad et al., 2008; Miltenberger et al., 2020). For example, with the focus of teaching firearm safety skills, researchers have evaluated BST to teach children not to touch the firearm, leave the room, and tell an adult immediately (e.g., Gatheridge et al., 2004; Miltenberger et al., 2004). During BST,

each participant was expected to rehearse each target behavior until he or she demonstrated the skill without the need for prompts. Across all studies, it is important that that participant continues to demonstrate the target behaviors being taught during training until they reach mastery criterion. Commonly, after the participant reaches mastery criterion and proves to be proficient in the target behaviors, they then undergo in situ assessments in various environments to test generalization. An in situ assessment is when the researcher sets up an assessment in a natural environment and tests the skills being taught without the participant knowing that they are being tested (Johnson et al., 2005).

The results of several studies have shown that for some participants who underwent only BST, the skills did not generalize to the natural environment (e.g., Gatheridge et al., 2004; Himle et al., 2004; Jostad et al., 2008; Kelso et al., 2007). For example, in 2004, Himle et al. evaluated BST to teach firearm safety skills to children. During the study, the child underwent individual training that consisted of instruction, modeling, rehearsal, and feedback. Once the child was able to engage in the skills without prompts, they then participated in in situ assessments. If the child was unable to perform the target behaviors during the assessment when they did not know they were being observed, in situ training was then implemented. The results of this study showed that only three of the eight participants met mastery criterion following BST. The other participants needed additional in situ training. After in situ training was implemented, four of the five remaining participants achieved criterion and these skills were maintained. Likewise, Jostad et al. (2008) also taught firearm prevention skills to children, however, this study evaluated peer tutoring. Each peer tutor was trained by the researcher to use BST to teach the safety skills to the participants. After BST, only three participants achieved

criterion performance while the other three participants needed in situ training to achieve criterion.

BST has also been evaluated to teach poison prevention, abduction prevention, and pedestrian safety skills to children with autism (e.g., Gunby et al., 2010; Gunby & Rapp, 2014; Honsberger, 2017). Most of these studies concluded that BST was effective for some children but that other training, such as in situ training, was needed for the skills to generalize to in situ assessments and maintain over time. For example, Gunby et al. (2010) used BST with in situ feedback to teach abduction safety skills to children with autism. In this study, target behaviors were taught using instruction, video modeling, live modeling, rehearsal, and corrective feedback or praise. During these BST sessions, participants were taught to say “no,” run away to a safe place, and report to an adult when a stranger presented a lure. Each participant learned to respond to four different types of lures which included simple (“come with me”), incentive (“come look at all the puppies I have in my car”), authority (“your parents told me to pick you up”), and assistance request (“come help me look for my lost puppy”). Once the participant was able to independently and accurately respond to lures during BST rehearsal, abduction probes were conducted. During each probe, if the participant did not respond to the lures using each target behavior, the hidden researcher immediately entered the room where the assessment was taking place and provided instructions and corrective feedback. The results of this study showed that while BST was effective in teaching the abduction prevention skills, in situ feedback was needed for maintenance and generalization. In addition, Gunby and Rapp (2014) evaluated the use of BST and in situ feedback to teach safety skills to children diagnosed with autism to protect them against abduction lures. They found that while BST did not work

for any of the three children; they did not exhibit the safety skills during in situ assessments until in situ feedback was implemented.

When evaluating the effectiveness of an abduction prevention program, Sanchez and Miltenberger (2015) found that the use of BST did not result in the generalization of the target behaviors; say “no,” immediately get away from the perpetrator, tell a trusted adult about the encounter. In situ training was needed for all participants to maintain the skills during follow-ups. Although BST is one of the most studied methods for teaching safety skills to children with autism, it is not always effective with typical children or children with autism. Fortunately, the addition of in situ training enhances the effectiveness of BST in most cases (Gatheridge et al., 2004; Gunby et al., 2010; Himle et al., 2004; Miltenberger et al., 2004).

### **In Situ Training**

Using in situ training (IST) to teach safety skills is typically done by a researcher placing each participant in a natural environment where a threat is likely to occur and simulating the safety threat (King & Miltenberger, 2017). If the participant does not engage in the correct target behaviors when the simulated threat occurs, the unseen researcher steps in immediately and provides training in that environment (King & Miltenberger, 2017). King and Miltenberger (2017) evaluated video modeling to teach children diagnosed with autism how to avoid poisonous substances. During their study, if the child was unable to achieve criterion using video modeling alone, IST was implemented. During an IST session, the researcher instructed the child to engage in all three target behaviors and then practice each target behavior in a variety of scenarios. After each scenario, the researcher praised the participant if they engaged in the target behaviors correctly and provided corrective feedback if incorrect. IST was

conducted until the participant successfully demonstrated all target behaviors for three consecutive trials. IST was then followed by an in situ assessment within 3 days. IST worked for all participants but one. This participant only exhibited the safety skills once tangible reinforcement was used in training sessions.

IST has been shown to be effective in teaching safety skill to children with autism such as abduction prevention, firearm safety, poison safety, and sexual abuse safety skills (e.g., Fisher et al., 2013; Gunby & Rapp, 2014; King & Miltenberger, 2017; Miltenberger et al., 1999; Morgan & Miltenberger, 2017). To teach firearm safety skills to children with autism, Morgan and Miltenberger (2017) placed a disabled firearm in a predetermined location and instructed the child to enter the room for a variety of made up reasons; the child did not know that an assessment was being conducted. Once the child located the firearm, if he or she did not engage in the target behaviors don't touch, "get away," and "tell an adult," the researcher, or in some cases parent, would step in and have the child rehearse the appropriate behaviors. This training was repeated until the child scored a 3 for three consecutive assessments

Similar to studies that addressed firearm safety skills, studies have evaluated IST for teaching children with autism how to avoid poison hazards. During in situ assessments, the researcher placed a simulated hazardous substance in a predetermined location and had the child enter that room alone. A hidden researcher watched the participant to see if they engaged in the target behaviors which was not to touch the hazardous substance, walk out of the room, and report the substance immediately to an adult. If the child did not engage in the safety skills, the researcher then entered the room and began a training session with the child in that environment (King & Miltenberger, 2017).

During BST, reinforcement (praise) is provided for the safety skills during role plays in the presence of the researcher in training sessions. However, during IST, reinforcement is provided immediately for the correct response in the natural environment where the child encountered a seemingly real safety threat while alone. Reinforcement of the behavior in the presence of the safety threat in a natural environment is likely what causes this training method to be one of the most effective tools for promoting generalization. Research has shown that this training is effective for a number of safety skills with children with autism (e.g., Bergstrom et al., 2014; Fisher et al., 2013; Gunby et al., 2014; Morgan & Miltenberger, 2017; King & Miltenberger, 2017).

Although IST is effective in promoting generalization of safety skills to children with autism (Morgan & Miltenberger, 2017; Sanchez & Miltenberger, 2015), there are some limitations from past studies that future researchers should take into account. One issue is treatment fidelity. Beck and Miltenberger (2009) taught participants', children aged 6 to 8 years old, parents to implement to prevent abduction. A concern of theirs was the fidelity of IST being implemented by two of the parents and the parent's location during assessments. If the parents implemented the training differently from one another or were seen during the assessment, the child would get confused on what is expected or the visibility of the parents could remind the child what he or she is supposed to do when a stranger presents a lure. Gross et al. (2008) taught parents to implement BST and IST and reported a similar issue with treatment fidelity.

A limitation discussed in Gatheridge et al. (2004), a study that looked at the use of IST to teach firearm safety skills, was that each assessment was conducted individually. In a real-world situation, the child might be with siblings or friends and should learn to demonstrate the safety



skills even if others were present. Fortunately, Miltenberger et al. (2004) conducted dyad assessments following training and showed the skills occurred even if a peer was present.

One other limitation of IST is that it requires the researcher to set up an in situ assessment and implement training in that context if the child fails to demonstrate the safety skills (Miltenberger et al., 2020). Therefore, IST requires intensive time and effort on the part of the researcher that may make this training approach inaccessible to many.

Lastly, King and Miltenberger (2017) discussed how IST is not always effective alone and sometimes needs to be paired with a tangible reinforcer. During this study, if participants, 6-year old's diagnosed with autism, did not reach mastery criterion after IST, access to a preferred tangible was given after the participant demonstrated all target behaviors. The incentive condition was needed for one participant, and while this helped the participant reach mastery criterion, it did not assist in maintaining the skills. Other researchers also showed IST was not effective in some cases until a tangible reinforcer is used (e.g., Miltenberger et al., 2004). Therefore, more research is needed to determine when and with whom tangible reinforcement is needed in training.

### **Video Modeling**

Video modeling is a way of teaching safety skills by using a video recording to provide a visual model of the target behaviors (Mechling et al., 2009). The recording can be of actors performing the desired skills or the researcher can record the participant being prompted to engage in the correct target behaviors and edit out the prompts to show only the correct behavior in the presence of the safety threat. This form of video modeling is called video self-modeling (Dowrick & Dove, 1980). Additionally, the video being shown can also engage the

participant by having a narrator ask questions in the video and having the participant respond out loud (e.g., Godish et al., 2017; Morgan & Miltenberger, 2017). If the study involves this type of interactive video, the researcher will give the participant a predetermined amount of time to respond after a question is asked and if the participant does not respond, the researcher will prompt a response. If the participant does not respond correctly, the researcher will correct the response (King & Miltenberger, 2017). By making the video interactive, the hope is that the participant will be more engaged in watching the video so they will learn the skills being modeled.

Video modeling has proven to be time and cost efficient; therefore, research has evaluated video modeling to teach a variety of safety skills such as extinguishing fires and social safety skills (e.g., Mechling et al., 2009). However, this type of training has not been consistent in promoting generalization of safety skills (e.g., King & Miltenberger, 2017; Morgan & Miltenberger, 2017; Spivey & Mechling, 2016). This type of training has also not been consistent in proving that taught skills maintain over time and in some studies, other training was needed, such as IST (e.g., Morgan & Miltenberger, 2017).

What makes video modeling different from BST and IST is the fact that during video modeling training sessions, the participants are watching and attending to the video, and maybe even interacting vocally in reciting safety skills (Mechling et al., 2009). However, rehearsal and feedback are not implemented so the participant never practices the skills (Godish et al., 2017). These steps are possibly the key in promoting generalization and why BST and IST are so successful. However, not all research found that video modeling did not promote generalization. In fact, some research found that the use of video modeling actually did

promote generalization of the skills with maintenance of the skills when video modeling was no longer present (e.g., Godish et al., 2017; Mechling et al., 2009).

Although video modeling seems to be the most convenient, cost and time efficient training method to show realistic unsafe scenarios, and can do so in a variety of ways, there are still limitations. One limitation is that the findings in the studies are inconsistent with video modeling being an effective tool to teach children with autism safety skills in some cases (e.g., Godish et al., 2017) and not being an effective tool in others (e.g., King & Miltenberger, 2017; Morgan & Miltenberger, 2017). Additionally, researchers addressed confounding variables that may be present during video modeling. For example, Sokolosky (2011) stated that some participants displayed off task behavior to gain attention from people in the present environment. While researchers try to avoid variables such as additional people walking around during the assessment and intervention sessions, sometimes it is not avoidable. This variable may have interfered with the participants' ability to demonstrate the target behaviors.

### **Simulation Training**

Simulation training is the use of small-scale models of common environments in which the threat or safety concern is likely to happen. Each model is built and decorated with small scale furniture, trees, or any other items needed to make the environment resemble the "real life" environment. To accurately resemble the participant, the researcher then gets dolls of varying races, ethnicities and genders. During the small-scale simulation training, the participant manipulates the doll, resembling themselves, to engage in the target behaviors. For example, to teach firearm safety skills, the participant is instructed to move the doll into the room where the firearm is placed and will be given an instruction by the researcher such as

“pretend to eat dinner.” The firearm will have already been placed on the dinner table chair and from there, the participant will have the doll engage in the target behaviors (Maxfield et al., 2019). The researcher then uses BST to teach the participant to have the doll engage in the safety skills in the model in the hopes that the skills will generalize to in situ assessments. Maxfield et al. (2019) showed that small scale simulation training was effective in teaching typically developing children to engage in gun safety skills when finding a gun in the natural environment.

Using small scale simulation training is a time and cost effective way of teaching important safety skills. These skills can be taught in the comfort of the participant’s own home and peers or caregivers can be taught to implement this intervention. Page et al. (1976) had a small scale model of various types of intersections and used the model to teach pedestrian skills to adolescents with disabilities. They used BST to teach the participants to engage in correct street crossing with their doll. Page et al. found that the use of small-scale simulation training increased the use of pedestrian skills in the natural environment when the participants crossed the street at a variety of intersections. Neef et al. (1978) also found that safe bus riding skills generalized to the natural environment when they combined small scale simulation and on-site training to their participants. In this study, the participants were trained to ride the bus using small scale simulation and then a researcher modeled the target behaviors to the participant at the bus stop and while on the bus (Neef et al., 1978).

One of the main concerns about small scale simulation for teaching safety skills is that there is not enough research to make strong claims about its effectiveness (Maxfield et al., 2019; Neef et al., 1978; Page et al., 1976). More research needs to determine if this

intervention is effective in teaching safety skills and if these skills will generalize to the natural environment. Additionally, results of Page et al. (1976) indicated that their use of a simulation model with personalized pictures was effective. Future research should duplicate this or compare the use of personalized simulation models to non-personalized models. Finally, another limitation discussed in studies is the lack of diversity in simulation training models (Maxfield et al., 2019). Most studies can only focus on one or a few simulation models so it is not clear if the skills taught will generalize to novel locations or if the participant will only be able to perform the skills in settings simulated by the model.

### **Virtual Reality**

Virtual reality is the use of technology and computer graphics to create an immersive program that resembles the “real world” (Goldsmith, 2008). This type of computer program is different from what people see on a desktop. Immersive virtual reality is normally played or used with the use of a headset that blocks the user’s peripheral vision so the user can only see what is on the screen in the headset. The programs respond to the user’s movements and behaviors in real time allowing the user to interact in the imaginary world making this experience feel real (Goldsmith, 2008; Padgett et al., 2006). Additionally, this technology allows learning programs to be presented in an entertaining way and allows the child to learn at their own rate (Padgett et al., 2006).

Most people use virtual reality as a gaming platform or for job related tasks. With the advances in this technology, big companies and organizations such as the National Aeronautics and Space Administration and the Military use this technology to train and to do research. Although many people still believe virtual reality is a new form of technology, it has actually

been around since 1962 and for some time has been accessible to the public for a steep but realistic price (Goldsmith, 2008).

It is not as well-known as a therapeutic tool as it is a gaming platform, however, the use of virtual reality is present in the world of therapy. Virtual reality is used for different treatments such as exposure therapy, adjunctive treatment of pain, wheelchair practice, movement practice for patients who experienced trauma, stuttering help, functional communication in aphasia, and social skills interventions (Andrae, 1996; Botella et al., 2006; Brundage, 2007; Garcia et al., 2007; Hoffman et al., 2004; Ira, 1997; Mitchell et al., 2007; Padgett et al., 2006). In addition to these applications, virtual reality has been evaluated in a few studies to teach safety skills to children with autism (Dixon et al., 2019; Goldsmith, 2008; Josman et al., 2008; Self et al., 2007).

Goldsmith (2008) stated that two of the safety skills that are most frequently taught with virtual reality are pedestrian skills and fire safety. Virtual reality is a great tool to teach children with autism a variety of skills because each program can be visually enhanced and can be tailored to the individual's needs (Self et al., 2007). Virtual reality can also serve as a tool to promote generalization which has been known to be a difficult task to accomplish with other approaches to teaching safety skills (e.g., Gunby et al., 2014; King & Miltenberger, 2017; Self et al., 2007). Researchers are hopeful that this type of training can be beneficial to children diagnosed with autism in teaching safety skills because much previous research has shown that IST is needed for the skill to generalize (Goldsmith, 2008; Miltenberger et al., 2020) and virtual reality is able to create an in situ environment.

Goldsmith (2008) studied the use of virtual reality to enhance BST to teach children with autism pedestrian safety skills. In this study baseline and follow-up assessments were conducted in the natural environment at street crossing locations. The target behaviors were to have the participant stop and wait a safe distance from the curb, look left and right for traffic, walk and continue looking, and to have the participant use the crosswalk. In each training VR session, the participant entered the virtual reality world and had to maneuver him or herself across the street using all target behaviors learned. In this study, all five participants mastered the street crossing skills in the virtual reality environment. However, the results of generalization to the natural environment were mixed.

In 2007, Self et al. evaluated virtual reality to teach children with autism fire and tornado safety skills in a school setting. In this study, baseline was conducted using in situ assessment during real time fire and tornado drills during their typical school day. Following baseline, each participant was taught how to use virtual reality. This included instructions on how to manipulate the mouse and how to move in the virtual environment properly. The group of students who took part in the virtual reality condition received fire training through the virtual reality platform. This involved watching a guided tour of the target behaviors in an unknown building. Following the guided tours, the participants were then instructed to manipulate objects in the building while being virtually guided through an unknown building. Finally, the participants were expected to maneuver through the unknown building safely and without guidance. Following the virtual reality training in this study, each participant took part in a generalization phase. During this phase, the researchers evaluated whether this skill would transfer to real life. In situ assessments were conducted during a real time fire drill that

participants took part in. The results of this study showed that each participant was aware of the need to respond to the fire, however, each participant needed additional prompts to respond completely.

Dixon et al. (2019) evaluated the effectiveness of virtual reality for teaching pedestrian skills to children with autism. In this study, three participants underwent in situ assessments during baseline. Sessions were on streets located in the community near the participant's homes. Following baseline, training sessions were conducted in a clinic setting and each participant took part in desensitization sessions. Virtual reality training involved the participant watching a 10 s long video clip of either a safe (no cars passing on the street) or unsafe (cars passing on the street) situation. Researchers used prompting and fading to teach the target behaviors; look both ways, responding to the question "is there a car moving," and responding to the question "is it safe to cross?" Following each step, praise was provided regardless if the response was independent or prompted and access to a preferred activity was provided after the end of each trial. Additional training with distractors and with long videos was added and modified to aid in generalization. Following training, virtual reality probes were used to assess skill levels. During these probes, the researcher showed a video clip of a safe or unsafe environment and asked the participant, "is it safe to cross?" Finally, natural environment probes were conducted on streets in real life. The results of this study showed that virtual reality was an effective tool in teaching children with autism pedestrian skills. In addition, the virtual reality training used in this study was also effective in achieving generalization after the training modifications were made.



Although some research suggests it might be effective, there is little research on virtual reality for teaching safety skills. It is difficult to draw conclusions about virtual reality and its effectiveness with the lack of research to compare to other methods. Additionally, while virtual reality is an innovative concept, it is not always cost effective and does involve the need of a programmer. As more people become aware of this type of technology and its demand, the costs may decrease making it more accessible to therapists and behavioral training.

## **Conclusion**

The purpose of this review was to discuss a few safety threats faced by children with autism and examine the different training interventions used to teach safety skills to children with autism.

It is clear from the research reviewed that BST has been an effective training procedure with some participants and may produce generalization across different people and different settings. There are many studies that have used this type of intervention and have been successful with at least some participants. However, BST is not always effective, and it is not clear in advance when or with whom BST will be effective. When BST is not effective, IST has been proved to be an effective tool in generalizing the target behaviors to natural environments. This type of training intervention has been combined with BST, video modeling, small scale simulation and others not discussed in this review paper.

With few exceptions (Godish et al., 2017), video modeling has not proven to be an effective training procedure alone in promoting generalization of safety skills to natural environments. There are few studies that focus on video modeling and the studies that have used this type of training have varied results. When video modeling is paired with IST, it seems to be more effective in producing generalization of safety skills. It is clear that video modeling

can be cost and time efficient; therefore, more research should be done involving this type of intervention.

The use of small-scale simulation has also brought about varied results. While there is very little research out there on this type of intervention, some studies have proven that with training on a model involving manipulation of a doll, generalization to the natural environment is possible. More research should focus on evaluating the effectiveness of small scale simulation training for teaching a variety of safety skills to children with autism. Additionally, studies should focus more on a variety of small scale environments and test to see if these small scale environments generalize to environments not being taught in the small scale training.

Lastly, virtual reality shows promise, but not a lot of research backs up the effectiveness of this training intervention. While technology is always advancing, it is important to continue to do research on this type of training style. Virtual reality training provides the unique opportunity to children with autism that no other training intervention does, in situ training in the comfort of a known environment. Because children with autism are known to elope from unknown settings, conducting training in a home or school environment is most safe for the child. With the help of virtual reality, a child can have the closest experience to in situ training while being in an environment that is comfortable and familiar. Although it may be cost prohibitive at the moment, it is something on which future research should focus as technology advances.

The use of video has potential for future research. For example, with there being video modeling, video feedback, video-self modeling, and the choice of interactive and non-interactive videos, the possibilities are many. Although video modeling has been evaluated for

teaching a number of safety skills to individuals with autism (e.g., Godish et al., 2017; Honsberger, 2017; King & Miltenberger, 2017; Mechling et al., 2009; Morgan & Miltenberger, 2017; Sokolosky, 2011; Godish et al., 2017; Spivey & Mechling, 2016) it is not always effective, more research is needed to identify with whom and with what skills the use of video is likely to be effective.

For future directions, it is important to continue to evaluate video modeling in different settings, specifically in school settings. Teaching a child how to be safe in a school setting is important because every child has to attend some type of school; therefore, children are always in this environment. Additionally, because this environment is typically known as a safe environment, teaching children with autism how to recognize and respond to unknown adults on a school campus could help prevent a life-threatening situation (e.g., abduction, school shooter). Video modeling is also cost effective, time efficient and easy to implement which could be a significant deciding factor if caregivers, teachers, and others choose they want to use this training to teach their children safety skills. Lastly, future studies should focus on which other types of interventions are most effective when combined with video modeling. Understanding which combination of interventions is the most efficient would be important information for the success of future studies.

Overall, there has been important research evaluating procedures for teaching children with autism safety skills. Teaching children diagnosed with autism how to be more aware of their surroundings, how to safely respond to unidentified adults, how to respond to a fire, how to avoid and report poisonous substances around the house, how to walk safely across a busy street, and what to do when they see an unattended firearm are all important skills. It is

imperative to find easy to implement, cost and time efficient training procedures that not only researchers, but also peers and other adults in the child's life can implement. These skills will help reduce the rates of abduction, accidental fire fatalities, firearm fatalities, trips to the emergency room from accidental poison consumption, pedestrian fatalities, and so much more. The knowledge of which training is most effective will not only save children with autism, but will ultimately help the families, caregivers and communities in which they live and work.

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