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ORIGINAL PAPER

# Effects of Behavioral Skills Training on the Stimulus Control of Gun Safety Responding

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## Abstract

Teaching individuals a safety response when they encounter a firearm may be one way to prevent accidental injuries or death. Previous researchers have used behavioral skills training (BST) with and without in situ training to teach individuals with and without disabilities to engage in a safety response in the presence of a firearm. However, few studies have arranged BST to ensure the safety response occurred in response to a representative sample of all relevant stimulus features for which a response should be evoked. The purpose of the current study was to evaluate the extent to which BST conducted in a single context established stimulus control that would evoke the safety response across a range of contexts under which young children could encounter a dangerous stimulus in a room in their house. All participants demonstrated a discriminated safety response following BST. Further, safety responses generalized across all contexts not associated with training for all participants.

**Keywords** Behavioral skills training · Generalization · Gun safety · Safety skills · Stimulus control

This article is based on a thesis submitted by the first author, under the supervision of the second author, at Caldwell University in partial fulfillment for the requirements of the Master of Arts in Applied Behavior Analysis.

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## Introduction

Parents commonly take steps to increase the safety of their children. Common examples include requiring their child to wear a seat belt while in a car, removing toxic substances (e.g., household cleaners) to prevent poisoning, and teaching appropriate responses to common environment dangers (e.g., street crossing; Hanratty et al. 2016). Although these preventative measures are encouraging, parents may be unlikely to consider and teach their children how to respond appropriately to other dangers the parents believe the children are unlikely to encounter. For example, although firearms may be less frequently encountered than household toxins (Hanratty et al. 2016), gun ownership in the USA is as high as 57% (Siegel et al. 2013) and guns have a high potential to lead to injury or death (Miltenberger 2008). Unfortunately, children are likely to play with firearms when they encounter them (Miltenberger et al. 2004). Alarmingly, there were at least 27,000 fatal and nonfatal firearm-related injuries reported between 1993 and 2000 for children 14 years of age or younger (Eber et al. 2004). Programs that teach children how to respond safely in the presence of firearms may be one way to reduce the likelihood of firearm-related injuries. In such programs, a typical safety response involves the child not contacting the firearm, leaving the area containing the firearm, and reporting the presence of the firearm to an adult.

Education-based programs are one method for teaching children safety responses. For example, the National Rifle Association created the Eddie Eagle Gun Safe program to teach firearm safety to children. The program uses different age-appropriate activities to teach children to "Stop. Don't touch. Leave the area. Tell an adult" when they encounter a gun (Himle et al. 2004b). Although the Eddie Eagle Gun Safe program successfully leads to children saying the safety response (i.e., "stop, do not touch, leave the area, go tell an adult"), it has not been successful in teaching children to demonstrate the safety response in the presence of a firearm (Himle et al. 2004b). In contrast, researchers have successfully used behavioral skills training (BST) to teach children to respond appropriately in the presence of firearms (Himle et al. 2004a; Miltenberger et al. 2004; Miltenberger 2008).

Broadly speaking, BST involves instruction, modeling, rehearsal, and feedback. Specific to firearm safety response training, BST involves an instructor describing the danger posed by firearms and the responses (i.e., do not touch, leave the area, tell an adult) that should be evoked by the presence of a firearm. Next, the instructor models the complete safety response while the child observes. The instructor provides an opportunity for the child to practice the response, and provides positive and corrective feedback based on the child's behavior. The instructor provides repeated rehearsal opportunities with feedback until the child engages in the safety response independently at some predetermined criterion (Miltenberger et al. 2004). Following BST, the instructor typically arranges situations in which the child is in the presence of a firearm while the instructor is hidden from view (i.e., in situ assessment). The instructor provides in situ training (IST) if the child fails to independently demonstrate any component of the safety

response. Previous researchers have used BST with and without the need for IST to teach a variety of individuals (i.e., individuals with and without disabilities) to demonstrate a safety response in the presence of a firearm (Gross et al. 2007; Hanratty et al. 2016; Himle et al. 2004b; Jostad et al. 2008; Miltenberger et al. 2004, 2005; Rossi et al. 2017).

Although previous studies have shown that children and adolescents can be taught to engage in a safety response when they encounter a firearm, the influence of the stimulus conditions present when an individual encounters a firearm remains uncertain. More specifically, it is unclear to what extent individuals will demonstrate a safety response if they encounter a firearm in a context that differs in one or more ways (e.g., the location of the firearm, the presence and behavior of proximally located peers and adults) from the stimulus conditions present during the training context(s). For example, if an individual is exposed to BST to establish a safety response when encountering a firearm located on a table in an empty room, will he engage in the safety response if a peer encourages the individual to touch the firearm (e.g., "go ahead, pick up the gun") left on a table. In this example, it is not known if BST is sufficient to produce a safety response that would occur in contexts not included in training.

The purpose of the current study was to evaluate the extent to which BST conducted in a single context (i.e., the individual is told to go play in a room, encounters a firearm left on a table with no one present in the room) establishes stimulus control that would evoke the safety response across a range of contexts created to represent a range of stimulus conditions in which an individual may encounter a firearm in an area of their house.

## Method

### Participants

Three children of typical development were recruited. Two males and one female without a history of safety skills training related to handguns participated in the study. Joey was 6 years, 9 months old at the start of the study. He obtained a standard score of 122 (qualitative description: moderately high) on the Expressive Vocabulary Test—Second Edition (EVT-2; Williams 2007) and a standard score of 118 (qualitative description: moderately high) on the Peabody Picture Vocabulary Test—Fourth Edition (PPVT-4; Dunn and Dunn 2007). Ross was 4 years, 0 months old at the start of the study. He obtained a standard score of 111 (average) on the EVT-2 and a standard score of 124 (moderately high) on the PPVT-4. Rachel was 4 years, 7 months old at the start of the study. She obtained a standard score of 101 (average) on the EVT-2 and a standard score of 113 (average) on the PPVT-4. Out of the 110 potential points on the Health, Safety, and First Aid section of the Assessment of Functional Living Skills (Partington and Mueller 2012) Joey, Ross, and Rachel scored 69, 41, and 48, respectively. None of the participant's families owned a gun; however, they may have visited environments where a handgun could be present. For example, Rachel had a peer whose father was a police officer. All participants

demonstrated three-step direction following and low levels of problem behavior. A description of how these prerequisite skills were assessed is provided below. The first three participants who volunteered for participation and demonstrated the prerequisite skills were enrolled in the study.

### Setting and Materials

Training and generalization sessions were conducted in the basement of each participant's home. We selected the basement as the setting to represent a consistent location across participants and because it provided a feasible location to arrange the five contexts (described below). The basement contained minimally a table, couch, television, and television stand. We used a non-firing replica handgun (purchased from https://maxarmory.com) as the dangerous stimulus. The specific model, a Stalker M2918 Black Finish 9MM Blank Firing Replica Zoraki Gun, was selected based on the outcomes of a psychometric sort (described below). We identified a non-dangerous stimulus (e.g., a blow-dryer) that shared non-critical features (e.g., color, shape) with the handgun to test for appropriate stimulus control. We prevented the hair dryer from being plugged in by zip tying the cord and maintaining the rubber cover over the plug. Additional materials included data sheets, timers, pencils, and a video camera to record sessions.

### Psychometric Sort

We conducted a psychometric sort (Rosch 1975) to identify the replica handgun that would serve as the dangerous stimulus based on the dimension of typicality. We created 10 stimuli cards, each containing a picture of a replica handgun. We selected the 10 replica handguns depicted in each picture because each would be available for purchase and contained variation in non-critical features (e.g., size, color). We asked 10 graduate students to sort the stimuli cards by saying "Please order these cards from the most typical handgun to the least typical handgun." The most typical handgun was assigned a score of 1, and the least typical handgun was assigned a score of 10. We calculated the average position of each handgun by adding the scores given by the graduate students and dividing by 10. The handgun with the most typical average rating was included as the dangerous stimulus in the present study.

### Training Contexts

We created five contexts to evaluate participant responding. Each context varied with regard to the location of the dangerous or non-dangerous stimulus, the presence or absence of another individual, and the behavior of the other individual if present. These contexts were chosen to represent a range of contexts in which a child might encounter a dangerous stimulus at home. In the first context, the experimenter said, "Go play in the basement at the table. I'll come in soon" (or a similar variation). The stimulus was placed on top of a piece of furniture (e.g., coffee table) in the basement with no other individual present. In the second context, the experimenter said, "Go

hang out in the basement with (name of the adult present at the time).” The stimulus was placed on top of a piece of furniture in the basement with one adult present. The adult looked at their phone or sat on the couch in the basement while playing with the child. In the third context, the experimenter played with the participant and told him or her to “Go get (name of item) from under the television.” Participants were asked to retrieve common household items they reliably interacted with (e.g., television remote, a toy) in their basement. The stimulus was placed under the television inside the cabinet or a box. In the fourth context, the experimenter played with the participant in the basement and then said “You stay and play. I have to go get something from my bag.” The caregiver interacted with the stimulus (e.g., cleaning the handgun or hair dryer) for 30 s, placed the item within 1 m from the participant, and left the area to complete a task. The caregivers provided a neutral statement (e.g., “I’ll be right back, I need to go complete [a task].”) or placed the stimulus down and exited the basement without saying anything to the participant. In the fifth context, the experimenter said to the participant “Go play in the basement with your (peer or sibling).” In the basement, a peer or sibling attempted to coax the participant to interact with the stimulus. Peers/siblings were between the ages of 4 and 9 years. Table 1 provides additional details specific to each context when the dangerous or non-dangerous stimuli were present.

### Tact Pretest

Prior to experimental sessions, a tact pretest determined whether participants could name the experimental stimuli that would be used. This was a necessary skill because participants were required to report the name of the dangerous stimulus to an adult (i.e., “I found a *gun*”). We used a picture of the dangerous stimulus (based on the psychometric sort) and non-dangerous stimulus that were used in the study during the tact trials. During the tact pretest trials, the experimenter presented the picture and asked, “What is it?” The experimenter presented a total of five pictures the participant could reliably tact (i.e., balloon, crayon, apple) interspersed with the target pictures to ensure the opportunity for positive feedback in an attempt to maintain responding. The experimenter delivered vocal praise for unprompted correct responses across all stimuli. A neutral statement (e.g., “Okay”) was delivered for each unprompted incorrect response. The exemplars were presented one time to each participant, and their response was scored on a data sheet. An acceptable response to the dangerous stimulus was “gun,” and acceptable responses to the non-dangerous stimulus were “hair dryer” or “blow-dryer.”

An unprompted correct response was defined as the participant providing the predetermined target name of the picture within 5 s of the vocal discriminative stimulus (i.e., “What is this?”). An unprompted incorrect response was defined as the participant engaging in an error of commission or omission within 5 s of the discriminative stimulus. The target item was considered mastered when the participant labeled both the dangerous and non-dangerous stimuli correctly across two consecutive sessions. Both Joey and Ross met this criterion during the tact pretest. Rachel required teaching using vocal model prompts and vocal praise. The vocal prompt was faded using

**Table 1** Description of training contexts

| Context | Description | Individual present | Location of stimulus | Antecedent |
|---|---|---|---|---|
| 1 | While participant is playing in the basement alone, the stimulus is on the coffee table among an array of toys | None | On coffee table | Experimenter says, "Go play in the basement, I'll come in soon" |
| 2 | While participant is playing in the basement with a parent present (e.g., their mother), the stimulus is on a piece of furniture in the basement | Parent | On coffee table | Experimenter says, "Go hang out in the basement with (name of adult present at the time)" |
| 3 | Experimenter asks the participant to retrieve an item from under the television | Experimenter | Under the television inside a storage compartment | Experimenter says, "Go get (name of item) from under the television in the (name of storage compartment)" |
| 4 | While the participant is playing in the basement, the parent is cleaning the handgun. After the parent finishes cleaning the stimulus, he or she puts it down on the coffee table and leaves the basement | Parent | In parent's hand and on coffee table | Experimenter plays in the basement with participant. Experimenter says, "You stay and play. I have to go get something from my bag"<br>Experimenter leaves the basement<br>Parent is in the basement cleaning the handgun. Parent places stimulus within 1 m of the child. Parent leaves the basement |
| 5 | While participant is playing in the basement, a peer or sibling is also be present. The peer or sibling reaches out with the stimulus in their hand and tells the participant to play with the stimulus | Peer or sibling | In peer's or sibling's hand | Experimenter says, "Go play in the basement with your (name of peer or sibling)"<br>Peer or sibling tells participant to play with the stimulus |

a constant prompt delay (i.e., 0 s, 5 s). Rachel required four training sessions to meet the mastery criterion.

### Direction Following Pretest

This pretest determined whether participants could comply with three-step directions presented by the experimenter. This skill was necessary because training during BST required participants to complete a three-step safety response. The experimenter presented five three-step direction trials to each participant. The experimenter delivered vocal praise contingent on each unprompted correct response (defined as the participant completing each part of the direction within 10 s of the antecedent stimulus). Unprompted incorrect responses were defined as errors of commission or omission within 10 s of the antecedent stimulus. Following unprompted incorrect responses, the experimenter made a neutral statement (e.g., "okay"). The percentage of three-step direction following was calculated by dividing the total number of unprompted correct responses by the number of unprompted correct responses plus the number of unprompted incorrect responses and multiplying by 100. All the three participants scored 100% for direction following.

### Design, Dependent Variable, and Interobserver Agreement

A non-concurrent multiple baseline across participants design was used to evaluate the effectiveness of behavioral skills training (BST) on participants' acquisition and generalization of a discriminated safety response. Participant responding was scored in the presence of a dangerous stimulus and a non-dangerous stimulus. In the presence of the dangerous stimulus, a safety response was scored on a 0–3 scale. A score of 0 indicated that the participant touched the dangerous stimulus. A score of 1 indicated that the participant did not touch the dangerous stimulus, but remained in the vicinity of the stimulus, and did not report the presence of the dangerous stimulus to an adult. A score of 2 indicated that the participant did not touch the stimulus, left the vicinity of the stimulus, but did not report the presence of the dangerous stimulus to an adult. A score of 3 indicated that the participant did not touch the dangerous stimulus, left the vicinity of the stimulus, and reported the presence of the dangerous stimulus to an adult. Touching a dangerous stimulus was defined as any response that resulted in contact between any part of the participant's body and the dangerous stimulus. Leaving the vicinity was defined as any response that resulted in the participant moving at least 3 m away from the dangerous stimulus (we measured and noted this distance prior to the study). Reporting the presence of the dangerous stimulus to an adult was defined as telling an adult (the experimenter or caregiver) the name of the item that was found in the area within 15 s (the experimenter counted covertly) of leaving the area.

Participant responding in the presence of a non-dangerous stimulus was evaluated to ensure safety responding was under appropriate stimulus control. Participant responding was scored on a 0–2 scale in the presence of the non-dangerous stimulus. A score of 0 indicated that the participant left the area and reported the presence of

a non-dangerous stimulus to an adult. A score of 1 indicated that the participant left the area but did not report the non-dangerous stimuli to an adult. A score of 2 indicated that the participant did not leave the area or report the non-dangerous stimulus to an adult and could touch the non-dangerous stimulus.

An independent observer collected data on a minimum of 33% of sessions with each stimulus across each phase of the study from video for interobserver agreement purposes. Interobserver agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Agreements were defined as observers recording the same score for pre- and post-training responses. Disagreements were defined as the primary observer recording one score and the secondary observer recording a different score. Mean agreement was 94% (range 83–100%) for Joey, 94% (range 83–100%) for Ross, and 97% (range 91–100%) for Rachel.

### General Procedure

First, single-exemplar behavioral skills in situ training (SE-IST) was conducted to establish discriminated responding in context 1 (Table 1). After the participant met the mastery criterion during SE-IST, we evaluated the extent to which the discriminated safety response generalized to the remaining four contexts (contexts 2 through 5).

### Baseline

During baseline, participant responding was assessed in the presence of the dangerous stimulus across the five contexts as described in Table 1. Before each training context, the experimenter said the relevant antecedent vocal stimulus. If the participant engaged in the full safety response, the trial ended. Otherwise, the trial ended after 2 min or if the participant touched the dangerous stimulus. In either case, the experimenter entered the basement and said, "Let's go play in another room." Participant responding was also assessed in the presence of the non-dangerous stimulus across the five contexts as described in Table 1. Before each session, the experimenter said the relevant antecedent vocal stimulus. After 2 min elapsed, the experimenter entered the basement and said, "Let's go play in another room." If the participant engaged in the full safety response, the experimenter would have provided praise (this did not occur). Although it was not necessary, the experimenter would have guided the participant back to the area if the participant left the basement.

### Single-Exemplar Behavioral Skills Training

During single-exemplar behavioral skills training (SE-IST), BST was used to teach participants to differentially respond in the presence of a dangerous and a non-dangerous stimulus in context 1. One BST session was conducted with each participant. The mean duration of the BST session across participants was 13 min, 2 s (range, 11 min to 16 min). BST included instruction, modeling, rehearsal, and feedback.

During the instruction component for the dangerous stimulus, the experimenter held out the stimulus and said, "This is a gun. It is dangerous." Then, the experimenter said, "If you find a gun, do not touch it, leave the area, and tell an adult." The final part of the instruction component required the participant to repeat the vocal instruction. The experimenter instructed the participant to repeat what she said (i.e., "do not touch, leave the area, tell an adult"). If the participant did not repeat the instruction, the experimenter provided additional full vocal prompts until the participant successfully imitated the vocal model.

During the instruction component for the non-dangerous stimulus, the experimenter provided the vocal instruction "This is a hair dryer. It is *not* dangerous. If you find a hair dryer, you can stay in the area and play. You do not have to tell an adult about the hair dryer." The participant was then required to repeat the vocal instruction (i.e., "can play with it, stay in the area, do not have to tell an adult"). The experimenter provided additional vocal prompts as needed until the participant successfully imitated the vocal model.

Next, the experimenter modeled the safety response in the presence of the dangerous stimulus. She approached the dangerous stimulus, stopped before touching it, and said, "don't touch." Then, the experimenter walked 3 m away from the handgun while saying "leave the area." Finally, the experimenter approached an adult standing on the stairs leading down to the basement and said, "I found a handgun." The experimenter used vocal prompts as needed to guide the participant to complete each component of the safety response (e.g., participant walked up to the dangerous stimulus, refrained from touching it, and said, "don't touch"). Afterward, the experimenter modeled the appropriate response in the presence of the non-dangerous stimulus. The experimenter approached the item and said, "That's a hair dryer. I can stay in the area and play. I do not have to leave or tell an adult."

After the experimenter modeled the appropriate responses for the dangerous and non-dangerous stimuli, she told the participant "Now it is your turn to try." The experimenter arranged role-play opportunities using context 1 and provided the participant with positive and corrective feedback. The experimenter delivered behavior-specific praise for engaging in the complete response in the presence of the dangerous and non-dangerous stimulus (e.g., "awesome job not touching the gun!"). Corrective feedback specific to any component not performed correctly was provided. Corrective feedback specified what the participant did or did not do (e.g., "Remember, do not touch the gun. Instead go tell an adult."), and we required the participant to demonstrate the correct response (we used vocal and physical prompts as needed). Rehearsal and feedback continued until the participant demonstrated a complete response in the presence of the dangerous and non-dangerous stimulus five consecutive times (Miltenberger et al. 2004).

### Single-Exemplar Plus In Situ Training

During single-exemplar plus in situ training (SE-IST), participant responding was assessed when the trained dangerous and non-dangerous stimuli were presented in context 1 in the absence of the experimenter. These sessions were similar to baseline, except the experimenter provided positive and corrective feedback based on

participant responding. The experimenter delivered positive feedback (e.g., "I liked the way you did not touch the gun, left the area, and told an adult what you found!") contingent on the occurrence of a full response (i.e., score of 3 in the presence of a dangerous stimulus, and a score of 2 in the presence of a non-dangerous stimulus). If the participant did not complete all components of a response, the experimenter entered the basement and provided in situ training consisting of four components: instruction, modeling, rehearsal, and feedback (Himle et al. 2004a). For example, if the participant touched the dangerous stimulus, the experimenter entered the basement, said, "Remember, do not touch the gun, and tell an adult like this," and modeled leaving the area and telling an adult. The participant was then required to complete the appropriate response three consecutive times (Miltenberger et al. 2005).

The same procedure was used if the participant did not complete the required components to achieve a score of 2 in the presence of the non-dangerous stimulus. For example, if the participant left the area and reported the presence of a non-dangerous stimulus, the experimenter said, "Remember, you can stay in the area and play when you see a hair dryer." The participant then had to independently complete the appropriate response consecutively three times. Mastery was defined as the participant demonstrating the appropriate response for three consecutive sessions without corrective feedback.

### Response Posttest

A posttest was conducted to evaluate the participants' responses in the presence of the dangerous and non-dangerous stimuli in contexts 2 through 5. These sessions were the same as baseline. If the participant demonstrated the correct responses in the presence of the dangerous stimulus (i.e., does not touch, leaves the area, and tells an adult) and in the presence of the non-dangerous stimulus (i.e., stays in the area and does not go to tell an adult), the participant's participation was considered complete. If the participant did not respond correctly in the presence of either stimuli, the posttest ended. We would have then conducted BST in additional contexts until participants demonstrated correct responding in contexts not associated with training (i.e., train sufficient exemplars; Stokes and Baer 1977). However, this was not necessary for any of the participants in the current study.

### Procedural Integrity and Procedural Integrity IOA

An independent observer scored procedural integrity for 50% of sessions using a data sheet containing a list of steps specific to each component of the study (available from second author). Procedural integrity was calculated by dividing the total number of plusses by the total number of steps in the component. For all the three participants, procedural integrity was 100% across sessions.

A second observer scored procedural integrity for 100% of procedural integrity sessions for interobserver agreement purposes. Interobserver agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements multiplied by 100. An agreement was defined as observers recording

the same score. A disagreement was defined as the primary observer recording one score and the secondary observer recording a different one. Procedural integrity IOA was 100% for all participants.

### Social Validity

To assess the goals of the study, the parents of the participants were asked to complete an experimenter-created survey before the start of the study. The survey asked parents to rank potential household dangers (handguns, medications, cleaners, matches/lighters, and knives/sharps) from most to least dangerous, what they thought their child would do if they encountered a handgun, and how important it was for their child to learn how to respond appropriately to a handgun. Parents completed the form in the absence of the experimenter and then handed the completed form to the experimenter.

To assess the outcomes of the study, 20 graduate students were shown pairs of video clips (two videos from Joey, four videos from Ross, and four videos from Rachel) from baseline and the response posttest and asked to indicate on a data sheet in which video clip the participant demonstrated a correct safety response. We edited the video clips to end before showing the experimenter provides feedback to the participant. The order of the clips was randomized so that the baseline clip did not consistently proceed the posttest clip. Each pair of videos was from the same context (e.g., baseline video from context 2 and posttest video from context 2).

## Results

Figure 1 displays the participants' responding during baseline, SE-IST, and the response posttest when the handgun was present. During baseline, none of the participants demonstrated the complete safety response. Additionally, all participants touched the handgun at least once during baseline. Following BST, we conducted SE-IST. Joey, Ross, and Rachel met the mastery criterion in five, four, and three SE-IST sessions, respectively. Ross and Joey required more SE-IST sessions than Rachel because they failed to demonstrate the complete safety response during one (Ross) or two (Joey) SE-IST sessions. During the response posttest, all participants demonstrated the safety response across the four untrained contexts.

Figure 2 displays the participants' scores in the presence of the hair dryer. During baseline, every participant played with the hair dryer at least once. Following BST, we conducted SE-IST. All participants demonstrated appropriate responding in the presence of the hair dryer. That is, all participants touched (or did not touch) the hair dryer, remained in the area, and did not report the presence of a hair dryer to an adult. During the response posttest, all participants demonstrated the appropriate response in the presence of the hair dryer across the four untrained contexts. Taken together, the results depicted in Figs. 1 and 2 demonstrate that participants engaged in a discriminated safety response.

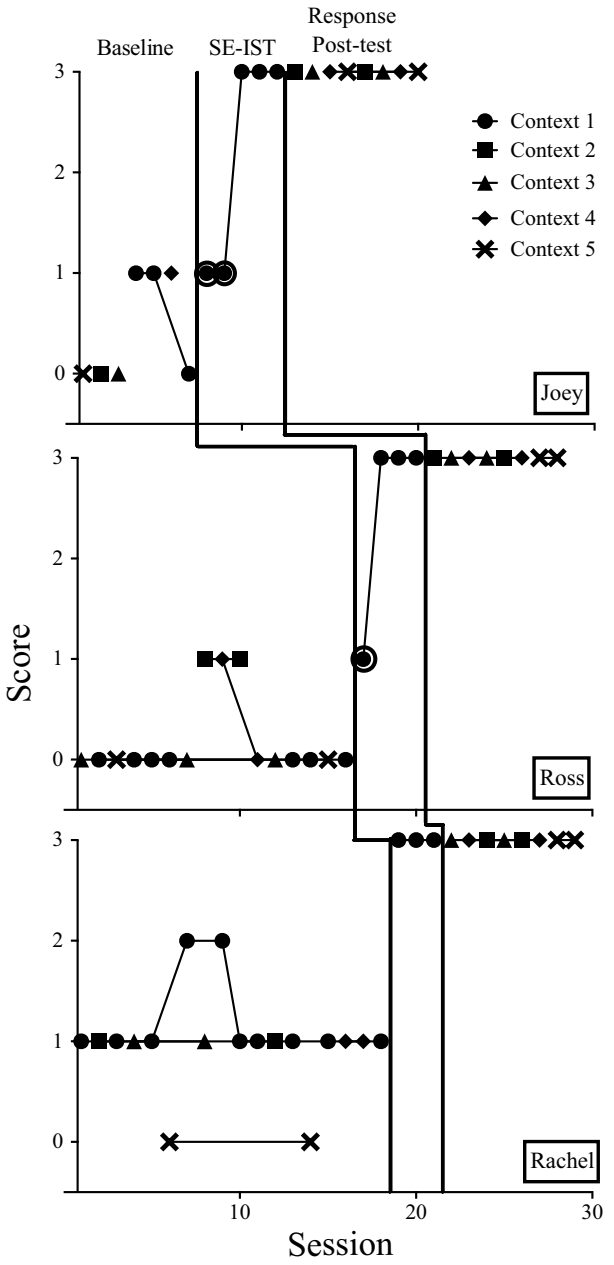


**Fig. 1** Safety response scores for the dangerous stimulus during baseline, single-exemplar plus in situ training (SE-IST), and response posttests across the five contexts. Circled data points indicate sessions that required in situ corrective feedback

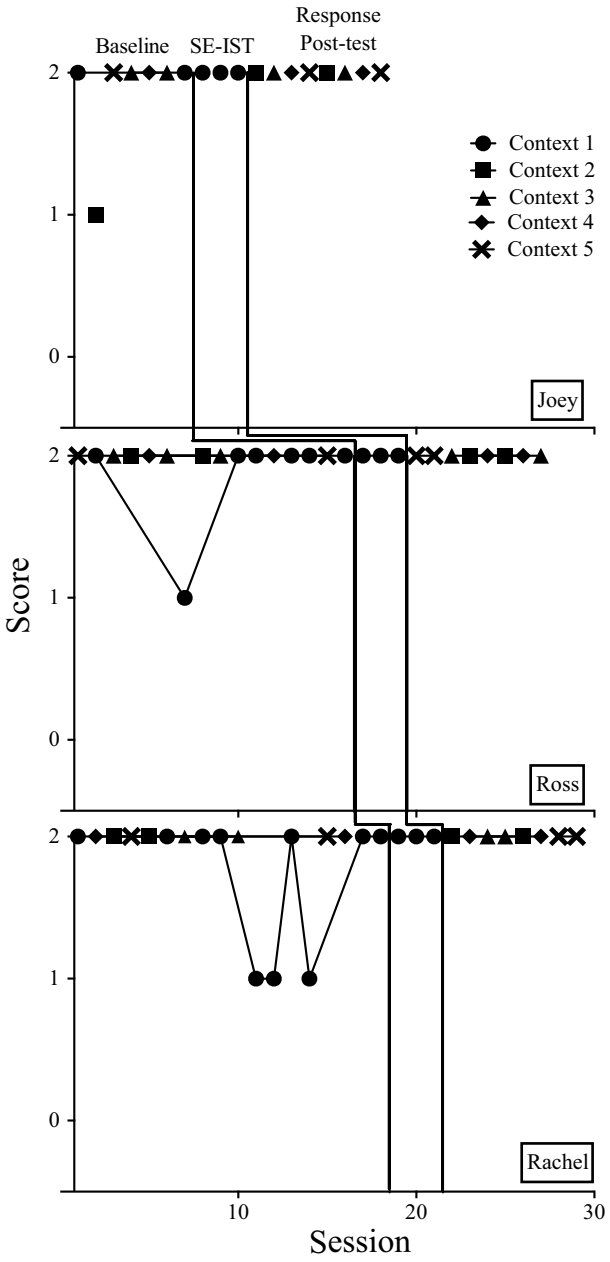


**Fig. 2** Safety response scores for the non-dangerous stimulus during baseline, single-exemplar plus in situ training (SE-IST), and response posttests across the five contexts

On the experimenter-created survey, all participants indicated that they considered handguns to be the most dangerous potential household danger. Additionally, all parents agreed it was important for their children to learn to respond safely in the presence of a handgun; two parents indicated their child would touch a handgun if found, whereas one parent indicated their child would leave the room and tell an adult. The parents reported their children had safety response training, but no handgun-specific training. The 20 graduate students, after watching a total of ten pre- and posttest videos, all selected the corresponding posttest video over the baseline video for the most appropriate safety response. These results indicated that the outcomes of the study were socially valid.

## Discussion

The purpose of the current study was to evaluate the extent to which BST conducted in a single context (i.e., the individual is told to go play in a room, encounters a handgun left on a table with no one present in the room) established stimulus control that would evoke the safety response across a range of contexts created to represent a range of stimulus conditions under which a child may encounter a firearm in an area of their house. All participants demonstrated a discriminated safety response following SE-IST, and this response was observed across all contexts not associated with training. These results provide preliminary support for the usefulness of SE-IST in establishing a safety response that occurs across trained and untrained contexts.

The results of the current study are in agreement with the previous research's that have demonstrated the usefulness of BST to teach children with and without disabilities to demonstrate a safety response in the presence of a firearm (e.g., Himle et al. 2004a; Miltenberger et al. 2004; Rossi et al. 2017). Relatedly, similar to a subset of participants in previous studies (e.g., Himle et al. 2004a; Miltenberger et al. 2004), two participants (Ross and Joey) in the current study required in situ corrective feedback. We attempted to prevent the necessity of in situ training by conducting BST in the context in which the safety response would be required. Future studies are needed to evaluate how BST could be modified such that in situ corrective feedback is not required. For example, one variable that could be manipulated is the BST termination criterion. Similar to previous studies (e.g., Miltenberger et al. 2004), we required participants to independently complete the safety response five consecutive times during a single BST session. A more stringent BST termination criterion (e.g., requiring additional consecutive independent safety responses; requiring independent safety responses across multiple BST sessions) may have established stronger stimulus control, thereby resulting in a decreased need for in situ training.

One variable not consistently reported in the safety training literature is the time required to complete BST. One exception is Rossi et al. (2017), who reported the duration ranges for the BST sessions and the total training duration for each participant. In the current study, the average duration of BST was about 13 min. The relatively short duration of BST appears to be a considerable strength, particularly considering that we established a discriminated safety response and the response occurred across all contexts not associated with training. Although the acceptability

of BST requires validation, the training duration required by the current participants appears to be quite feasible.

The current study also adds to the safety response training literature in several ways. First, we conducted pre- and post-BST tests to evaluate participant responding across a range of contexts in which we manipulated who was present in the room when the participant encountered the handgun. This differs substantially from previous studies in which the only context included involved the experimenter guiding the participant to an empty room where a handgun was left on a table. Relatedly, Himle et al. (2004a) previously suggested that future researcher should evaluate whether an individual would continue to engage in the safety response when pressured by a peer to interact with a firearm. Based on that suggestion, we conducted such an evaluation in the present study. In addition, we evaluated whether participants would respond in contexts in which another individual (e.g., parent) was present in the area. Under each context following BST, the participant demonstrated the safety response. To our knowledge, the current study is the first to assess the safety response in the presence of other individuals. Demonstrating the safety response in the presence of others is somewhat surprising considering we did not explicitly program for such generalized responding. That is, BST was conducted in a single context, and this context did not contain a number of variables that may influence participant responding (e.g., a peer directing the participant to interact with the handgun). Future studies are needed to evaluate the generality of this finding. Although we manipulated several variables across contexts, these manipulations occurred in the same room (basement) of the participants' houses. This arrangement could, in part, explain why participants demonstrated the discriminated safety response across contexts. That is, stimulus components of the basement were common to all contexts and could have served as a source of control over the participants responding. Similarly, we conducted BST, SE-BST, and generalization sessions in the same room which may have had the effect of creating indiscriminable contingencies of reinforcement and punishment. Future studies should conduct tests in rooms not associated with training.

Second, in previous safety response studies, only the participant was present in the experimental area and the conditions prior to the individual contacting the handgun were not manipulated. In the current study, we evaluated participant responding when the placement of the handgun and what occurred before the participant was able to contact the handgun was varied. To the best of our knowledge, this is the first study to assess different placements and/or manipulations of the handgun. These additional manipulations are important in the safety training literature because they represent a wider range of circumstances under which a child might encounter a handgun. Although we manipulated the placement of the stimuli and what occurred prior to the participant contacting the stimuli, we arranged the same stimuli across contexts. That is, the dangerous and non-dangerous stimuli were common to all contexts, and this could, in part, explain the participants' demonstration of the discriminated safety response. Future studies could include generalization tests with stimulus exemplars not associated with training.

Third, we trained participants to stay and play in the presence of a non-dangerous stimulus that shared some physical features (e.g., color, overall shape) with

the dangerous stimulus. We did so in an attempt to increase appropriate stimulus control; that is, we wanted to maximize the likelihood that the safety response was evoked by features specific to the dangerous stimulus and not features common to both the dangerous stimulus and other stimuli in the environment. In doing so, we were able to demonstrate that participants engaged in differential responding based on the presence of the dangerous or non-dangerous stimuli. To our knowledge, no previous studies have conducted such discrimination training or included tests to evaluate whether participants demonstrated the safety response in the presence of stimuli that shared physical features with dangerous stimuli. Although Rossi et al. (2017) did not test participant responding in the presence of stimuli that shared physical features with the dangerous stimuli included in that study, they did evaluate whether participants demonstrated the safety response in the absence of the dangerous stimuli. We recommend that other researchers continue to evaluate the need and usefulness of teaching a discriminated safety response in future studies.

The results of our social validity measure indicated parents considered a handgun to be the most dangerous household item and that it was important for their child to learn how to respond if/when they encountered a handgun. Previous research (Gross et al. 2007) has demonstrated parents can effectively implement BST to teach their children what to do when they find a handgun. However, additional research is needed to evaluate caregiver willingness/likelihood to employ BST in their home. Furthermore, future research could evaluate methods to train parents to implement safety training with their children in the absence of an experimenter/instructor.

We were unable to collect maintenance data. Because it is difficult to predict when individuals may encounter a dangerous scenario, it seems important that safety responses maintain over relatively long periods of time. Future studies should evaluate whether the safety response occurs across all five contexts for a period of time after participants meet mastery criterion.

Although educational-based programs may be easier to implement, behavior analytic research suggests these approaches are inefficient at teaching functional safety responses (Himle et al. 2004b; Miltenberger 2008). The current study demonstrated the effectiveness of BST and IST in establishing safety responses with generality to untrained contexts and establishing differential responding to dangerous and non-dangerous stimuli. Thus, these training methods may prepare children to respond to the danger of a handgun under a variety of contextual variables and may help establish best practices for teaching safety responses to children.

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## Compliance with Ethical Standards

**Conflict of interest** The authors declared that they have no conflict of interest.

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

**Informed Consent** Informed consent was obtained from all individual participants included in the study.

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